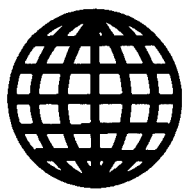


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# **Science & Technology**

***Central Eurasia:  
Earth Sciences***

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# Science & Technology

## Central Eurasia: Earth Sciences

JPRS-UES-92-005

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### Poor Outlook for Polar, Antarctic Weather Stations

927N0127A Moscow IZVESTIYA in Russian 29 Jul 92  
Morning edition p 2

[Article by Igor Andreyev, IZVESTIYA correspondent:  
"The Weather Service: Severe Forecast; the first paragraph is an introduction]

[Text] If during the month the Russian Hydrometeorological Service does not receive the necessary funds from the government it will have to immediately evacuate personnel from inaccessible stations, first of all from the Far North and from the Arctic. Already today, in the very few weeks of the short arctic navigation season, for almost the first time during the decades of existence of polar "meteorological points" the transport of fuel, food and special clothing is taking place with a great lag behind the usual schedule.

However severe the life of the winterers near the South Pole, although not in the parts of Antarctica where the polar workers are striking, important dramatic events are shaping up. Without reproach to the "southerners," receiving their pay in hard cash, I say: the "northerners" are not quibbling about payment in money. A total of 926 persons at hundreds of so-called "provisioned" stations, to which it is necessary to transport everything needed for life and work a year in advance, have faced the prospect of surviving without fuel and food.

However, note my interviewees, Aleksandr Bedritskiy, First Deputy Chairman of the Russian Committee for Hydrometeorology and Environmental Monitoring, and Petr Nikitin, head of the Arctic, Antarctic and Marine Administration, these northern problems in concentrated form only reflect the misfortunes of the entire branch. Since 1986, due to an insufficiency of funds and lack of specialists, it has been necessary to close about 330 stations in Russia. There has been a sharp increase in the prices of food, fuel and equipment, costs for aerial services and freight costs on sea ships. Whereas last year the rental of an Mi-8 in the North was 1200 rubles per hour, it is now 45,000 rubles. The department assigned to transport those on holiday from inaccessible stations to the mainland is not able to fulfill this point in the contract. It reduced the numbers of ice reconnaissances and the frequency of aerial measurements in the interests of agriculture and reduced the exploration of conditions aloft, made four times a day with pilot balloons, to two launchings per day. Working side-by-side with aviators, weather forecasters at 397 airport meteorological stations are earning many times less than those who report the weather. There is no guarantee that tomorrow it will be possible to purchase the unique hydrometeorological equipment manufactured today by a very few producers. The enterprises either are jacking the prices up to the limit or are simply ceasing to produce that which is needed by only one single client.

The gradual curtailment of the volumes of measurements, say my interviewees, for the time being is having no influence on the reliability of forecasts. In any case it is difficult to detect the influence of this factor against the background of the natural and admissible errors in weather prediction. However, the evacuation of personnel from the polar stations will instantaneously exert an influence on the quality of forecasts and will make it impossible to compile synoptic charts not only for the Arctic and Far North, but also for enormous regions the weather for which is "made," as is well known, in the high latitudes.

If in actuality it comes to an urgent evacuation of people from the polar stations the Far North will be threatened by not only transport, but also by industrial paralysis. Without a weather prediction not a single aircraft can take off and not a single sea ship can depart. Without a forecast there can be no export of timber from Igarka and the products of the combine at Norilsk cannot be exported. The diamond- and gold-producing regions of Yakutia and the copper, nickel and other provinces of the region will remain cut off from the mainland. The five million tons of freight annually transported along the Northern Sea Route will lie dead in the water in tens of ports. Transpolar enterprises will begin to sweat, not knowing what natural cataclysms, which will predicted by no one, will occur. Exhausted by every imaginable shortage, the people will not be able to depart from the zone of misfortune; in these severe places 90 percent of the passenger transport is by air.

The high commands of all types of armed forces feel that the insufficiency or total absence of weather forecasts will threaten serious loss to defense capabilities.

And finally, even after a year the restoration of the stations abandoned today will be impossible. The very fierce climate in just a few months will destroy the unoccupied structures, annihilate the equipment and will transform to ruins that which cost the country many billions.

In essence all those consequences of today's economy which have impacted the Hydrometeorological Service and which were mentioned above were reflected in a departmental note addressed to the government. Soliciting from it this year's shortfall of 1.5 billion rubles, the Russian Committee for Hydrometeorology and Environmental Monitoring asks that an immediate solution be found not only for the long-range problems of the service, but also for those which in no way can be put off. During the coming month it is necessary to purchase means of life support for the winterers, to introduce prepayment to middlemen and the merchant marine in order to be able in the open water season to transport annual supplies to the polar stations forgotten by God and man.

# **Earthquake by Command, or a Discussion on Whether Man Can Win Out Over Terrestrial Catastrophes**

927N0104A Moscow ZNANIYE-SILA in Russian No 1, Jan 92 pp 2-13

[Interview with Aleksey Vsevolodovich Nikolayev, professor, corresponding member, USSR Academy of Sciences, by ZNANIYE-SILA correspondent I. Galkin; the first paragraph is an introduction]

[Text]

In the summer of 1991 sensational communications appeared in the press: there is a direct dependence between nuclear tests and very strong earthquakes. To be sure, such communications could not leave people calm, especially those who live in seismically hazardous regions. Along these lines our correspondent interviewed one of the leading seismologists of our country, Professor Aleksey Vsevolodovich Nikolayev, corresponding member, USSR Academy of Sciences.

**Is It Possible to Control an Earthquake?**

**Correspondent:** Early in the summer of 1991 the mass media carried sensational reports on the possibility of controlling earthquakes by means of powerful explosions. They were based on your report at the international symposium in Baku in June of last year and a communication in DOKLADY AN SSSR. Is there actually such a possibility? Just what is so-called induced seismicity?

**A. Nikolayev:** The term "induced seismicity" appeared for the first time in connection with the filling of artificial reservoirs. A classical example is the construction of the dam and the filling of the reservoir in the neighborhood of Coima, India, which in a completely calm, aseismic region induced an earthquake with a magnitude 6. Then high dams began to be erected in many regions and an increase in weak and moderate seismicity also was noted there. It is true that in these cases there were no very strong earthquakes and catastrophes, but there were impairments and unpleasant consequences as a response to the filling of the water bodies.

In these cases a positive effect was that a knowledge appeared on how to operate a reservoir in order to lessen the danger of a strong induced tremor: the reservoir should not be filled too rapidly and the water should not be released from it too rapidly.

**Correspondent:** And then did the idea develop that tectonic stresses could be released artificially?

**A. Nikolayev:** This idea is old, and far from being ours. It was expressed in connection with mine shocks. And an experimental nuclear explosion even was set off in order somehow to shake up the rocks, to release stress.

For more than a decade we have already been occupied with somewhat different artificial effects: the influence of vibrations on the physical properties of rocks and the processes transpiring in them. In this way induced geophysical effects were discovered. Despite the fact that vibrators radiate microdoses of seismic energy, the simulation of seemingly stronger effects was obtained. From there it was possible to proceed to real scales. The principal conclusion was that rocks are influenced not only by constant or very slowly changing stresses, but also by seismic waves (speaking in a special language, they are not only tensosensitive, but also vibrosensitive). By working with elastic waves we can change the natural course of development of processes and see fine effects which exist in nature but are unnoticed under ordinary conditions.

After discovering that the vibrosensitivity of rocks is high, I thought: could not a strong, although remote earthquake exert an influence on an earthquake in another zone? And an explosion exert an influence on earthquakes, on the earthquake preparation process?

**Correspondent:** Despite the weakness of such influences due to their great remoteness? But under what other conditions?

**A. Nikolayev:** Well, because of the great energy of the source the amplitudes of surface displacement even thousands of kilometers from the focus are not so small: several microns. But most importantly, an earthquake must be ready to occur. It is only necessary to "give it a shove," to help "pull the trigger." And it will occur earlier and not continue to grow to a greater energy (magnitude). It's like by shaking an apple tree you prevent the apples from continuing their growth.

When processing catalogues of earthquakes and underground nuclear explosions a statistical analysis method was used which makes it possible to detect even very weak correlations among phenomena. The earthquakes of the Pamir-Hindukush zone and underground nuclear explosions at the Nevada and Semipalatinsk test sites were used as the "inducing" sources. The results were unexpected.

An influence of earthquakes and explosions on the situation in seismically hazardous zones was discovered at a distance up to 2000 km. This effect was manifested at different times at close and great distances, was somewhat different under the influence of explosions and earthquakes, but in principle it boiled down to one thing: the maturing of the focal zone for a seismic tremor was appreciably accelerated. Let's say that in the first five-day period after an underground nuclear explosion all the earthquakes occurred which would have occurred in the first seven days.

Thus, the Earth is stimulated to accelerated development. Let's say that an avalanche-like unstable fracture formation process transpires in the zone of a future focus and precisely it can be accelerated. The impact of an explosion, even a weak one, is observed in a large region

and not instantaneously, but lasts for several minutes with a magnitude 5-6. Such is the singular "homeopathy" which yields an appreciable effect.

In theory it is possible to "irradiate" a seismically hazardous zone by vibrational impacts as well, but for the time being we have not been able to do this. The intensities there are less but an effect can be obtained by means of a greater duration of the impact.

**Correspondent:** Is it possible to consider weak tidal moonquakes to be a model of induced seismicity?

**A. Nikolayev:** In a way. Moonquakes indeed occur on a "gravitational timetable," with a known periodicity—each half-month - month. The changing attraction of the Earth does not allow the accumulation of great stresses there. If there was a release on the moon, for example, once a year, there would probably be stronger events.

**Does a Tectonic Weapon Exist?**

**Correspondent:** Just what is a "tectonic weapon?" Could a nuclear explosion induce an earthquake in a stipulated region?

**A. Nikolayev:** A tectonic or seismic weapon would be the use of the accumulated tectonic energy of the Earth's deeper layers to induce a destructive earthquake. But here there is some terminological confusion. When speaking of an earthquake induced by an explosion some feel that this is only a "trigger" for an already prepared natural event; for others this is a region, never having known an earthquake, which suddenly experiences one if a nuclear bomb is detonated there. I, it goes without saying, feel that nothing can happen if the Earth is not ready.

**Correspondent:** Does that mean that earthquakes cannot occur in Moscow?

**A. Nikolayev:** Earthquakes cannot occur in Moscow and it is impossible to use a tectonic weapon against Moscow.

**Correspondent:** You recall, two or three years ago in Moscow there was a panic which developed about this, blown up, incidentally, by the press. "Day X" was awaited. Specialists of the Earth Physics Institute calmed the population from the pages of newspapers and the screens of TV sets. I, as a lecturer at the "Znaniye" Society, even had to write a note for a girl in the upper class telling her mama that there would not be an earthquake in Moscow sometime in July and there should be no concern about sending the kid to camp.

**A. Nikolayev:** Yes, then I and my colleagues—A. Nikonov, G. Sobolev, N. Shebalin, V. Sholpo and O. Starovoyt—had the task of debunking the threatening predictions. After all, scientists usually analyze a whole set of possible future scenarios. We, however, were submitted one single scenario consisting of a whole series of assumptions and fantasies, and each of the links in the

cause-and-effect chain was viewed extremely pessimistically. In any case, one should not speak out with categorical unchecked statements in the popular press, putting out scientific disputes for the court of public opinion, arousing alarm. Glasnost is glasnost, but it does not replace scientific ethics and responsibility and finally, common sense. And Moscow is located outside zones of seismic hazard, strong earthquakes do not occur here. It is another matter that waves may arrive from a distant focus. Dishes may rattle and chandeliers may sway, but this is not dangerous.

**Correspondent:** Well, what about there where the Earth is ready? Let's say, Gazli in 1976 and 1984? Were these earthquakes not initiated by underground nuclear explosions at the Semipalatinsk test site?

**A. Nikolayev:** In general underground explosions make an extremely appreciable increment to natural seismicity. Let's say that there were about 500 explosions in Nevada and about 300 at Semipalatinsk. As a result a very large region—Anatolia, Iran, Central Asia—slightly restructured their seismic regime. Earlier very strong earthquakes (with a magnitude 8) had occurred there. Now there is a deficit of events of that magnitude: technogenic intervention of man by means of explosions has forced the Earth to tremble a little more frequently and a little more weakly.

With respect to Gazli. Yes, 11 earthquakes with a magnitude greater than 5 occurred there, including three that are well known, destructive, and all of them occurred immediately, several days after explosions at the Semipalatinsk test site. But it was not only explosions which exerted an influence on them. A double influence was operative there. First of all, natural tectonic stresses had already accumulated there. Judging from geological data, strong earthquakes had occurred there. Academician A. Yanshin and Professor V. Ulomov already wrote earlier that this is a potentially seismically hazardous region. In addition, under the influence of gas production there had been a change in stratum pressure. In the last stage of earthquake preparation the stability of the process was already lost and it became sensitive to external influences. And here, so to speak, to overfill the cup of tectonic patience, a last drop—a nuclear explosion—was adequate.

**Correspondent:** We recall the rumors and conversations after the Spitak earthquake of 1988 that it was induced by ill-wishers, that it was not an earthquake, but an explosion. What would you say along these lines?

**A. Nikolayev:** I would say that this is idle talk, a fantasy, having no basis at all. After all, it is all documented. If someone doubts and does not believe the official data they can inspect the seismograms, the materials from the registry of geophysical fields, and convince themselves that there are no anomalies there which could be identified as explosions.

The international community for two decades has already been concerned with the problem of man's

possible impact on the ambient geophysical medium. The Soviet Union presented for the consideration of the UN a proposal that a convention be signed on banning modification of the environment and climate for military and other purposes incompatible with the interests of international safety and human well-being and health. A draft of the convention was presented in which, among other things, it was proposed that a ban be placed on the "excitation of seismic waves resulting in earthquakes by any means and methods." The convention entered into force in 1978 and already there are about 60 signatories. The Soviet Union became one of the first and is undeviatingly adhering to the convention.

**Correspondent:** But, indeed, there may be violators of the convention. Is the initiation of a seismic tremor possible from the seismic point of view? For example, for well-meaning purposes?

**A. Nikolayev:** We have already discussed examples of well-meaning actions. But to set oneself the objective of inducing an earthquake is an extremely doubtful undertaking. In theory seismically hazardous zones are known. But it is not easy to identify where a tremor will occur precisely after 10 days—that would mean solution of the earthquake prediction problem. If the problem of predicting the time and place of an earthquake is solved, in theory it would be possible to use such knowledge in order to actuate events. As if a rock on a slope is about to fall but we cannot wait until it falls and give it a push. But in general a tectonic weapon is a far-fetched possibility.

**Nevertheless:** Is it Possible to Predict the Time of an Earthquake?

**Correspondent:** In connection with the discovered possibility of releasing tectonic stresses has this not pushed the earthquake prediction problem into the background?

**A. Nikolayev:** The seismic hazard-safety problem includes a whole series of aspects: prediction of place, intensity, time, seismic-resistant construction, monitoring, induced seismicity, seismic weapons and seismic protection. To a certain degree the prediction problem remains the most important. In general, seismology is developing from one strong earthquake to the next strong earthquake. The first "governmental decree" on seismology of His Imperial Majesty was the law on allocation from the State Treasury of sums for the maintenance of the seismic institutions of Russia, adopted after the Verni catastrophic earthquake of 1911. The next was associated with the Yalta earthquake (1927), then the Ashkhabad earthquake of 1948. There has not yet been any such action since the Spitak earthquake. Money was promised for developing a modern seismological observation system, but for the time being no money has been appropriated.

**Correspondent:** What effect will this system give? Will the expenditures on its creation pay for themselves?

**A. Nikolayev:** One. A new observation network will make it possible to improve the quality of seismic zoning. Two—construction work will be in conformity to more valid recommendations of seismologists. Then a long-range prediction can be considered, which in essence merges with seismic zoning. Seismic zoning defines the general probability of a strong earthquake in a given place over the course of 100-1000 years. But a long-range prediction is for a period up to 10 years. And therefore it will be possible, in an appropriate way, to plan both economic activity and construction and antiseismic measures and the readiness of civil defense. In short, it is necessary to live by the proverb "be strong where it is necessary and weak where this is possible."

And if this was done in such a way the losses from earthquakes would be less. During the 45 years taking in the Ashkhabad, Spitak and Osetia events the losses amounted to about 20 billion rubles. They could have been reduced by at least 30 percent. And if at least 1 percent of this was taken for the development of seismology, it would live comfortably.

**Correspondent:** Some scientists feel that prediction of the time of an earthquake is impossible and this means it also is unnecessary....

**A. Nikolayev:** It is not the business of scientists to decide whether a prediction is necessary or not. That's what they can think sitting there in Moscow. But tell that to someone whose kindergarten child was buried at the time of the Spitak earthquake.... It seems strange to me that they sit around in Moscow and argue about whether or not it is necessary.

**Correspondent:** And is it possible or not?

**A. Nikolayev:** It is possible with some probability. We make a probabilistic prediction. Let's say, for next week in a given region with a probability 0, a few percent, tens of percent there will be a tremor with a magnitude greater than such-and-such. And let the authorities decide how to act: issue a warning, evacuate people, mobilize rescue crews or do nothing. But in general, a solution of the prediction problem is not something which will come about soon, but even now it would be possible to have good-quality construction. Then prediction would not be such a sore problem.

#### Shadow Seismology

**Correspondent:** In this connection let's touch upon the subject of seismic prophets, one might also say "shadow prediction." Readers of newspapers and journals of the recent post-Spitak years are familiar with a whirlwind of projects, literally an assault of people making predictions from both inside and outside science. In particular, they have tumbled onto the Earth Physics Institute, where you are deputy director. What interrelationship do you now have with these "shadow seismologists"?

**A. Nikolayev:** Yes, there have been a good many stories. The most important of them have been associated with



the names of such predictors, known from the press, as E. Nesmeyanovich, V. Ivannikov and O. Martynov. The Interdepartmental Council on Seismology and Seismic Resistant Construction and the Earth Physics Institute, USSR Academy of Sciences, have had to enter into a prolonged dialogue with them.

The story of O. Martynov, a Tula metallurgist, is particularly demonstrative. Here also there are great pretensions, supersecrecy, new physical fields and philosophical principles. The beginning of the story was an article in PRAVDA in June 1989, the story of three correspondents about a visit to a small secret underground laboratory where earthquake precursors were supposedly registered using a "barrel, permeated by pintles," an instrument "developed on a completely new physical basis," the concept of "openness of systems, taking into account direct connections and feedbacks." Despite the supersecrecy, it was possible to penetrate into this barrel. As we assumed, there was neither a method nor a prediction. The question arises: and just how and why did Martynov receive financing from the USSR Council of Ministers (if PRAVDA is to be believed, three million rubles) and why, despite false predictions of earthquakes for Petropavlovsk-Kamchatskiy and Alma-Ata, is a system of his instruments being organized in Kazakhstan? There are still many other "whys," but the answer to these questions, it seems, lies deep—in the conversion of military industry. The Ministry of Communications, and the newspaper PRAVDA, and the Ministry of Defense, all were involved in this tangle of problems. But this is a separate fascinating story.

**Correspondent:** And recently how has the supply of funds been? Has everything continued?

**A. Nikolayev:** Yes, in Kazakhstan work is continuing on construction of a test range for the prediction of earthquakes supplied with the supersecret Martynov instruments.

**Correspondent:** And what makes these independent predictors of earthquakes distinctive? Do they have something in common, something characteristic?

**A. Nikolayev:** Sure. First of all, they are actively engaged in self-promotion. They abuse professional science. In many cases the Academy of Sciences provokes their special hatred and irritation. Second, under different pretexts they avoid expert evaluations. Third, it is easy to manipulate the facts: unsuccessful predictions are declared to be successful; after a strong earthquake they declare that they predicted it in advance. And last. Earlier in their proofs they frequently appealed to the classics of natural science and Marxism-Leninism; now there is evidence of a switching to astral motifs and all kinds of devilry like the poltergeist. It must be said that all this is not just characteristic for our prophets. Our country is no exception in this sense. So it has happened in the United States, in Japan and in other countries.... There the press has now "grown up" and the matter of

predictive information has now been brought under control. But this was only after the "Peruvian drama."

In Peru the American seismologist Brady, ignoring the opinion of colleagues, notified the press of an impending, so he postulated, seismic catastrophe. A panic began and the flow of tourists was reduced. In essence there was an economic diversion, inflicting billions of losses on the country. Brady could not be held responsible—there were no appropriate laws. But subsequently the UN recommended to scientists and authorities that they not divulge predictive information bearing on the territory of another country. A specialist communicates a professional secret only to colleagues. This also applies, it goes without saying, to one's own country: the predictive information checked by experts should be conveyed to the government. The authorities, in making a prediction public, assume total responsibility.

That is why in the USSR Academy of Sciences there is a special system for the review of predictive information. Expert analyses are made in the Interdepartmental Council on Seismology. Unfortunately, these rules are violated, specialists do not keep secrets, the authorities do not know what to do and no law has been written for prophets. Who will answer for the ill-considered, false predictions which have filled the country? We know their geography from phone calls and letters. There are more than enough irresponsible predictions. But to cancel them out is more difficult; courage as well as knowledge are required. The press, probably without wishing it, in many cases creates a stressful situation. The press, we feel, should also correct it.

To Know What to Fear

**Correspondent:** What should be the level of sophistication of press coverage of complex problems in seismological science related to the life of the population? How should the population be taught, how should its level of seismic sophistication be raised? We live in a complex, contrasting, psychologically stressed time, the people are waiting for life to get easier and are becoming susceptible to rumors and sensations. On the other hand, science indeed has not been successful in earthquake prediction....

**A. Nikolayev:** Without question the popularization of scientific results among the broad masses is extremely important, we are not always aware of this and most likely we are not doing this successfully. It is necessary to write about seismology regularly and competently. Some level of seismological information should be inculcated as an element of general knowledge. This is particularly important for those who live in seismically hazardous zones. They must know what to fear and what not to fear and how to conduct themselves at the time of danger. In the United States, for example, a child's record and booklet have been issued and the children sing and thus remember where to run and what to do. We, unfortunately, do not have popularly disseminated publications on this theme.

Now about the test of credibility, the crisis of confidence. There always was a crisis of confidence—in the intelligentsia, in scientists and in the fundamental sciences. They say that “they” sit there and waste money, God knows on what. This crisis is related not only to the unconditional imperfection of our knowledge, but also is due to the fact that among us there is such a “practice” of many years that someone must be the fall guy. A strong earthquake occurred. Why did it occur? Either because there were scientists so intelligent that they induced it and so subtly and cunningly that it occurred precisely at Spitak. Or, they say, the scientists are such fools that they throw taxpayer dollars to the wind and still cannot predict earthquakes. Such are the polar points of view.

It must be understood what can be expected from scientists and what cannot be expected. There is a fundamental ambiguity in solving a number of problems; there is a definite limit to the possibilities for investigating the Earth by geophysical methods. Seismology learns from the strongest catastrophic earthquakes. When they occur we obtain a chance of understanding them better. They occur rarely—there is little teaching material. This, to be sure, does not mean that we regret that they are rare. But it must be realized that we will learn all our lives. And our grandchildren will learn.

If the same level of science existed a thousand years ago as now exists we would know a great deal on how earthquake precursors behave in each region and how to discriminate them subtly. What should be relied on, what should not be trusted.... But now the painful learning process continues.

**Correspondent:** Once you said that for a precise and detailed knowledge of the Earth's structure and the earthquake mechanism it is necessary to know so much, I quote you—“each cobblestone must be replaced by a seismometer.” What investments will suffice seismology today, in our day of an all-encompassing deficit and universal crisis?

**A. Nikolayev:** I think that now is not the time to establish supersystems, but the time to plant potatoes and sow grain. It is necessary to survive the difficult period and keep going. It is necessary to work well with those means already at our disposal and improve them. The call for a supersystem is nothing more than an attempt to justify one's impotence: “if only we had such-and-such instrumentation and computers, then we would be able to do everything!” The well-known economist Tereshchenko called this “hidden sabotage.”

**Intervention Must be “Smooth”**

**Correspondent:** So in conclusion let's discuss what seismology contributes to the life of people. Could its influence be both positive and negative? Is it appropriate to speak of seismoecology?

**A. Nikolayev:** Yes, if you have specifically induced seismology in mind. If one speaks of the preservation of the environment, it must be assumed that the artificial technogenic influence should be delicate, consistent with the course of natural geodynamic processes and not lead to undesirable consequences. So that there be no impairment, but possibly an improvement in the natural equilibrium.

If we know how to release tectonic stresses on a regular basis, this will lead to ecological well-being, although it also represents an intrusion into nature. And from this, only from this special point of view, underground nuclear explosions make a positive contribution to seismicity. They would be favorable because the stresses in the Earth's crust would be released by tremors of magnitude seven, not eight, instead of seven, six.

To be sure, nuclear tests must be banned for other reasons—ecological, moral. And here seismology plays a positive monitoring role.

Another example—seismic prospecting of oil-bearing structures. An extremely necessary business. There are also drawbacks: the productive soil layer is disrupted, as is the equilibrium of ground water. But seismologists are seeking a solution: the Earth's natural oscillations are used, nonexplosive, shock and vibrational wave sources are being employed. Incidentally, vibrational impacts are proving to be favorable for stimulating oil output from deposits.

And finally, there is the ecology of the human psyche. Here the science of seismology is helping to prepare people; it can ward off alarming rumors and groundless fantasies and fears. It is helping to provide protection against nervous overloads, care for and strengthen the spiritual health of people. This also is not by any means the last task of seismology.

**While This Number of the Journal Was in Press**

In October 1991, while this number of the journal was already in type, a prediction of a destructive earthquake was issued for Checheno-Ingushetia. It added great fear and agitation to the sociopolitical situation. At that time Aleksey Vsevolodovich Nikolayev appeared on television with an “antiprediction.” We asked him, in supplementing the already prepared interview, to comment on this heated situation.

**A. Nikolayev:** In my opinion, and this is not only my opinion, but also that of expert seismologists, in Checheno-Ingushetia no one had the data for making a short-range prediction of a destructive earthquake. That information which is available contains no indications warranting issuance of an alarm. To be sure, more detailed geophysical observations would be necessary in this region, but this is a matter of the future. However, an analysis of the available data also made it possible to say: there was no basis for making a short-range prediction for the coming month in Checheno-Ingushetia.

However, seismic activation of the entire Caucasus region is now being observed and a strong earthquake in the Northern Caucasus, including in Checheno-Ingushetia as well, is possible. Only its anticipated probability is far less than is assumed in the short-range prediction.

With respect to the "Political announcement" of the Executive Committee of the OKChN (All-National Congress of the Chechen People) of 14 October 1991, published in the newspaper GOLOS CHECHENO-INGUSHETII on 18 October 1991, in which it was stated that it was rumored that Russian seismologists knew about the earthquake preparation and that it could be artificially induced and intensified, I say concisely and firmly: we did not know and could not know!

The false information published in the newspapers MEGAPOLIS EKSPRESS and KOMSOMOLSKAYA PRAVDA caused a misunderstanding here. Paraphrasing the well-known French proverb, I say: "Seek the journalist." Unfortunately, the press in many cases is careless.

**Correspondent:** And have you already had the occasion to "cancel" earthquakes?

**A. Nikolayev:** You don't cancel an earthquake, but I participated many times in cancelling earthquake predictions: I cancelled short-range predictions of a strong earthquake at Beijing (at the request of the Soviet embassy), at Petropavlovsk-Kamchatskiy, Alma-Ata, Stavropol, in the Crimea and even in Moscow. And in Checheno-Ingushetia, as you see.

**Correspondent:** And how did it go with your "antipredictions"?

**A. Nikolayev:** For the time being they have proven correct.

**Correspondent:** What are your feelings about the authors of unsound predictions?

**A. Nikolayev:** Sympathy. For the most part these are people who have gone astray, although not all, to be sure, who were mentioned in the interview. It is impossible to change their minds. The only thing that can be done is somehow to calm down the press, which in many cases creates and supports these people.

**Correspondent:** And therefore your attitude to the press is ....

**A. Nikolayev:** As a seismologist—cautious, distrustful. This does not apply, to be sure, to the journal ZNANIYE-SILA, with which I have long collaborated.

[The following related excerpts were printed in the margins of the above article.]

**Berlin Courier:** Herr Professor, you evidently had to have a great amount of boldness as a citizen in order to venture into a field which the military holds in great secrecy?...

What do see will be the result?

**A. Nikolayev:** The breaking of a dangerous silence. We cannot wait for a hole to be formed in the Earth similar to that which exists in the ozone layer above our heads...

Berlin Courier, 17 June 1991

...The Caspian, as a result of uncontrollable industrial activity... is being transformed into a "heavy machine gun" strafing all regions along its perimeter with salvos of earthquakes.

**I. Kirimov,** doctor of physical and mathematical sciences, "When the Earth Trembles," TRUD (Work), 19 June 1991

"...I personally had the opportunity to study three of Martynov's claims. There can be no talk of secrecy here. Everything has been known since the middle of the 18th century and is based on the principle of the Cavendish pendulum. The reliability of the prediction here is low, even under ideal conditions."

**O. Khavroshkin,** corresponding member, Academy of Natural Sciences, "So You Want to be a Prophet," TRUD, 27 September 1990

"...The prediction which you made did not hold up. A panic among the population could be prevented only by considerable efforts. Indemnities are required to compensate for the expenditures.... Attempts of individual persons to acquire popularity in this field have inflicted considerable losses on the state. I ask that you adhere to the earthquake prediction rules and regulations established by the USSR Academy of Sciences."

**S. Negmatullayev,** academician, Tajik Academy of Sciences (Telegram to Martynov), "So You Want to be a Prophet," TRUD, 27 September 1990

...Such an alliance as between the welding department of Professor O. Martynov and the Volna Scientific Production Association of the Ministry of Communications has no relationship to seismology. Usually such a union yields painful results.... I feel that there should be legal responsibility for the issuance and publication of any seismic predictions...."

**Ye. Sedov,** candidate of physical and mathematical sciences, "So You Want to be a Prophet," TRUD, 27 September 1990

"...In the focal region of the future earthquake the radioactive gas radon, carbon dioxide, helium and hydrogen begins to be released intensively from the ground water. Radon fills the cellars and basements of dwellings. An increase in the concentration possibly depresses the human psyche..."

"You don't mean to say that..."

"Precisely. The earthquakes at Spitak, Uzen, in Moldova and Romania, and now in Georgia, occurred after or against the background of massive bloody conflicts when, as it seems looking from aside, the behavior of people went beyond all reasonable bounds...."

Conversation with F. Yudakhin, corresponding member, Kirgiz Academy of Sciences, "If 'the Roofs Are Eaten Away' the House Also Will Tumble Down," KOMSO-MOLSKAYA PRAVDA, 7 May 1991

"...Several days prior to the Spitak earthquake there in actuality was a nuclear explosion near Semipalatinsk, but a far stronger influence on the focus was exerted by an earthquake in Iran, occurring the day before. To speak of ill-intentioned inducement of the Georgian earthquake is still more absurd since nuclear tests in the USSR were then stopped."

A. Nikolayev, "Induced Earthquake?", POISK (Search). July 1991

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### Horizontal Refraction During Sound Propagation Through Intrathermocline Lens in Ocean

927N0119A Moscow IZVESTIYA AKADEMII NAUK  
RAN: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 28 No 6, Jun 92 (manuscript received 2 Sep 91)  
pp 582-587

[Article by Yu. P. Lysanov and V. Ye. Ostashev, Acoustics Institute; UDC 551.463.2]

[Abstract] The horizontal refraction of an acoustic wave intersecting an intrathermocline lens in the ocean is examined. The angle of horizontal refraction was estimated earlier by Munk for a case when the acoustic path passes through a mesoscale eddy. This article examines three plane models of an eddy with a cylindrically symmetric speed of sound distribution. The section of this lens by a horizontal plane is approximated by a circle. It is assumed that the trajectory of the acoustic ray lies in the horizontal plane, which is approximately correct for rays propagating in the ocean with small glancing angles. Vertical refraction within the limits of the lens is neglected, which makes it possible to obtain a simple analytic solution of the problem and on its basis an upward estimate of the considered effect can be made. A distinctive feature of the model is that the principal speed of sound drop occurs in a circular ring situated at the edge of the intrathermocline lens. Such a distribution qualitatively coincides with the speed of sound distribution in an intrathermocline lens recently discovered in the Atlantic Ocean. Expressions are derived for the maximum angle of horizontal refraction. It was found that this angle is  $1.5^\circ$  for the considered warm intrathermocline lens and  $-4.4^\circ$  for a cold mesoscale eddy. Figures 3; references 9: 8 Russian, 1 Western.

### Numerical Computations of Dispersion Relation for Nonlinear Surface Waves in Sea of Finite Depth

927N0119C Moscow IZVESTIYA AKADEMII NAUK  
RAN: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 28 No 6, Jun 92 (manuscript received 5 Aug 91,  
after revision 13 Dec 91) pp 648-653

[Article by V. A. Kalmykov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences; UDC 551.466.3]

[Abstract] Dispersion relations and the phase velocities of surface waves at different depths were derived on the basis of the equations of motion of surface gravity waves with allowance for depth. The influence of the second harmonic on the dispersion relation and phase velocity is demonstrated. A comparison with an experiment in deep water was made. The JONSWAP and Phillips spectra of different widths were used in the analysis. Computations of the dispersion relation and phase velocities of surface gravity waves at different depths indicated that the dispersion relation is satisfied well in deep water for slightly nonlinear waves; with a decrease in depth the dispersion relation is satisfied for essentially nonlinear waves. The following conclusion is unexpected: the

linear dispersion relation and the phase velocity for a shallow depth are satisfactorily described for essentially nonlinear waves. This conclusion can be understood if it is taken into account that with a decrease in depth the dispersion of the waves decreases and all the harmonics move with an identical velocity, which indicates a linear dispersion relation. On the other hand, a decrease in depth results in an increase in the nonlinearity of surface waves and as a result, a weakening ("blurring") of the frequency and phase velocity dependencies. Figures 3; references 6: 5 Russian, 1 Western.

### Formula for Computing Light Absorption by Suspended Marine Particles

927N0119D Moscow IZVESTIYA AKADEMII NAUK  
RAN: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 28 No 6, Jun 92 (manuscript received 24 Oct 91)  
pp 668-669

[Article by K. S. Shifrin and Glauco Tonna, Oceanology Institute, Russian Academy of Sciences, St. Petersburg; Atmospheric Physics Institute, CNR, Rome; UDC 551.463.5]

[Abstract] A formula for the coefficient of absorption of light by suspended marine particles, both terrigenous and biogenous, was derived earlier (1983) by K. S. Shifrin on the assumption that such particles are homogeneous spheres. Such particles can be regarded as slightly refractive. In the geometrical optics approximation for such particles it is possible to neglect:

- 1) ray reflection on the particle surface,
- 2) ray refraction upon entry into the particle.

This makes it possible to determine the radiation energy absorbed in a particle by summing absorption in individual linear rays penetrating a particle. These reasonings served as the basis for deriving the fundamental formula. Although this formula was derived for large slightly refracting particles it also gives true results for small particles. A new expression for the  $K_{abs}$  section is obtained if absorption is studied on the mean path of rays penetrating a particle. A formula is derived which makes it easy to determine this parameter. It is shown that the mean path of the ray in a particle is  $\frac{2}{3}$  of its diameter. Accordingly, a new expression is found for the absorption cross section which is not only simpler, but also somewhat more precise than the earlier proposed formula. It is easily used for computing absorption by polydispersed systems. For many particle-size distribution functions it is now easy to obtain explicit expressions for the quantity of radiation heat generated in a unit volume. Figure 1; reference: 1 Russian.

### Correlations Between Quantity of Precipitation, Water Temperature and Sea Level Along Southern Coast of Crimea and Parameters of Large-Scale Atmospheric Circulation in North Atlantic

927N0145A Moscow OKEANOLOGIYA in Russian  
Vol 32 No 3, May-Jun 92 (manuscript received  
11 Jan 91) pp 446-451

[Article by A. A. Sizov, A. A. Yeroshko and A. K. Kuklin, Marine Hydrophysics Institute, Sevastopol; UDC 551.465.7.(261.1)]

[Abstract] A study was made of the correlations between large-scale atmospheric circulation and moistening processes over Europe and the European USSR. The length of the series of hydrometeorological elements used in analyzing their year-to-year changes was confined to the period 1950-1990. A high-frequency Munk filter with a smoothing interval 11 years or five-year moving averaging were used in suppressing the annual and quasibiennial components in the initial values of the hydrometeorological elements. In years of best-developed atmospheric circulation over Europe and the southern coast of the Crimea there is a decrease in precipitation totals during the winter months which evidently results in a decrease in coastal runoff into the Black Sea and a decrease in its level along the southern coast of the Crimea. Synchronously with this process in the western part of the Black Sea an atmospheric circulation develops which leads to an intensification of westerly winds. The currents of a westerly direction near the southern coast of the Crimea caused by the westerly winds give rise to surge phenomena and a sea level decrease. With a weakened circulation in the northern hemisphere there is an increased moistening during winter in Europe and on the southern coast of the Crimea with a simultaneous weakening of the westerly winds near the southern coast of the Crimea and an increase in Black Sea level. Figure 1; references 24: 21 Russian, 3 Western.

### Statistical Characteristics of Sea Surface Slopes Observed at Different Wind Speeds

927N0145B Moscow OKEANOLOGIYA in Russian  
Vol 32 No 3, May-Jun 92 (manuscript received  
25 Apr 91) pp 452-459

[Article by G. N. Khristoforov, A. S. Zapevalo and M. V. Babiy, Marine Hydrophysics Institute, Sevastopol; UDC 551.465.4]

[Abstract] Using a laser slope meter (similar to those described elsewhere in the literature) mounted on an oceanographic platform at Katsiveli in the Black Sea measurements were made in the summer and autumn of 1989-1990 to determine the statistical characteristics of sea surface slopes under different meteorological conditions. Sea depth at this point is 30 m, corresponding to "deep water" conditions for wind waves in the Black Sea; distance from the shore was 650 m. Data were registered in digital form, about 1000 readings in each

record. The parameters of the two-dimensional distribution were evaluated using an expansion into a Gram-Charlier series. The results of research on the slopes of wind waves at wind speeds 0.8-11 m/s (62 records) for the most part correspond to those obtained by Cox and Munk. Table 1 gives the statistical characteristics of wind wave slopes for different wind speeds; Table 2 gives the statistical characteristics of the slopes of the "smoothed" sea surface in slicks. An analysis of these data shows that the dynamics of change in the dispersion of slopes in natural slicks associated with internal waves or calm conditions differs considerably from the Cox-Munk data for artificial slicks created as a result of a spill of petroleum products. Figures 2; references 9: 2 Russian, 7 Western.

### Concentration and Statistical Distribution of Sizes of Air Bubbles Generated by Wind and Black Sea Coastal Waters

927N0145C Moscow OKEANOLOGIYA in Russian  
Vol 32 No 3, May-Jun 92 (manuscript received  
11 Jan 91, after revision 5 May 91) pp 460-465

[Article by P. A. Kolobayev and A. Kh. Dekterev, Marine Hydrophysics Institute, Sevastopol; Acoustics Institute imeni N. N. Andreyev, Moscow; UDC 551.463/465.7]

[Abstract] Experimental data are given on the concentration of wind-generated air bubbles and their statistical distribution by size in a coastal region with a sea depth about 30 m. The research, carried out in 1989, was from a fixed platform on piles 1 km from the coast by the remote photographing of bubbles in a water volume at depths 1.5-15 m when the prevailing winds were 7-11 m/s. The apparatus used consisted of an automatic AFA-39 camera, three light sources and a control panel. The camera, in a watertight housing with transparent window, was lowered into the sea at a distance 40 m from the edge of the platform and connected to the control panel on the platform by a multistrand cable. The camera was drawn to greater depths by an underwater electric winch on the sea floor. The camera container was positioned at a stipulated depth after which a water volume with bubbles was photographed. The photographed water volume was illuminated by three light beams by flash lamps operating synchronously with the shutter. The axes of the light beams were in the plane perpendicular to the optical axis of the objective, at an angle 120° relative to one another. Measurements were made when there were steady wind waves. In the case of a low bubble concentration averaging was carried out for 40-50 photographs; in the case of a high concentration—15-20 photographs. The bubble images were measured by a measuring microscope to an accuracy 10<sup>-4</sup> cm. Conclusions are drawn on bubble size as a function of depth. Figures 4; references 5: 2 Russian, 3 Western.

### Geoacoustic Research in Nile River Cone Region

927N0145D Moscow OKEANOLOGIYA in Russian  
Vol 32 No 3, May-Jun 92 (manuscript received  
27 Dec 90) pp 600-603

[Article by N. N. Dmitrevskiy, V. N. Kuznetsov, A. V. Kulikov, A. V. Nosov and T. G. Kharatishvili, Oceanology Institute imeni P. P. Shirshov, Russian Academy of Sciences, Moscow; UDC 551.462.54]

[Abstract] On the 13th cruise of the research ship Rift profile hydroacoustic research was carried out in the western part of the Nile River cone using a multiray towed sounder. The processing system used in the sounder forms a fan of rays in the plane of movement of the towed capsule in a range of angles  $\pm 45^\circ$  from the vertical. The parameters of the collecting and processing unit make it possible to analyze the amplitude characteristics of the received signals in a range of distances 150 m along each of the formed rays at an arbitrary range from the sounder. The research runs were in E-W and W-E directions beginning with the isobath 250 m and to depths of about 500 m; each run was about 5 km in length; sounder towing rate was 1.5 knots. The sounder can analyze the signals separately for each of the rays, thereby registering signals reflected not only from the bottom, but also those backscattered by the bottom and sedimentary layers. This makes it possible to pinpoint formations in the bottom materials, describe the characteristics of scattering of individual layers and within the framework of existing geoacoustic models to select the corresponding parameters of the sedimentary layers. The collected data were compared with published data on the geologic structure of the studied region for constructing a geoacoustic model of the bottom and sound-scattering sedimentary layers. Specific results for the Nile River cone are given. The proposed model is deemed of importance as an illustration of the possibilities of use of multiray sounders when carrying out geoacoustic work in the ocean. Figures 2; references 7: 4 Russian, 3 Western.

### Combining of Shipboard and Satellite Data on Ocean Surface Temperature

927N0138B Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 30 Sep 91) pp 53-60

[Article by D. A. Larin, Institute of Global Climate and Ecology; UDC 551.526.6:551.507.22/.362]

[Abstract] A method is proposed for joint use of shipboard and satellite data for plotting charts of ocean surface temperature (OST). The following approach to the problem was selected. An objective analysis of OST at points of intersection in a regular grid is carried out separately using shipboard and satellite data. The resulting objective analysis fields are combined by means of solution of the variational problem for retrieving the OST field, which corresponds to the requirement of a minimum of a proposed functional F.

The need for using this functional is dictated by the fact that the data from the Meteor-2 satellites used in preparing the combined OST fields are less precise than shipboard data. The advantages of this variational approach are discussed. An experiment was carried out for testing the method using real data for an area  $20^\circ\text{N}$ - $25^\circ\text{S}$ ,  $130^\circ\text{W}$ - $80^\circ\text{W}$  using Meteor-2 satellite data for 27-30 November 1989 with interpolation at the points of intersection of a regular grid. An analysis using shipboard data was modeled by the climatic field T. As a result an OST field was obtained with boundary conditions determined by the climatic values and an internal structure determined by satellite data. The proposed variational approach ensures a quite inexpensive and effective method for combining shipboard and satellite OST data. Figures 2; references 9: 5 Russian, 4 Western.

### Influence of Cloud Cover on Diurnal Variation of Ocean Surface Layer Temperature

927N0138C Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 11 Jul 91) pp 61-67

[Article by P. O. Zavyalov, State Oceanographic Institute; UDC 551.526.6:551.576.31]

[Abstract] A theoretical analysis was made of the role of cloud cover in formation of the diurnal temperature variation in the surface layer of the tropical ocean. The author earlier formulated and solved this problem for low-latitude regions of the ocean in the absence of a cloud cover (IZV. AN SSSR: FAO, Vol 27, No 1, 1991). Drawing upon this earlier research, pertinent formulas are proposed. The results of computations made with them satisfactorily agree with observational data. Quantitatively the role of cloud cover is essentially reduced to a change in the quantity of solar radiation and effective radiation. The influence of cloud cover on the diurnal temperature variation is extremely complex. Allowance for cloud cover results in a change in amplitude, phase and shape of the diurnal temperature variation curve. The nature of these changes also is dependent on the depth of the considered point in the surface layer. Water temperature was measured at half-hour intervals at eight depth horizons from 2 to 37 m. The appearance of cloud cover results in a decrease in the diurnal variation by a factor of about 2-3, accompanied by a change in the phase and shape of the curve. An attempt was made at theoretical reproduction of these changes. Numerical computations were made for horizons 2, 7 and 17 m. At depths 2 and 7 m the model satisfactorily reproduces the actual variation, but at greater depths the correspondence is lost. In general, to depths of 10 m the computations satisfactorily reproduce the observational data. Figure 1; references 18: 11 Russian, 7 Western.

### Joint Spatial Interpolation of Thermohaline Fields in Ocean

927N0138D Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 11 Dec 91) pp 68-73

[Article by V. A. Sokolov, State Oceanographic Institute; UDC 551.465.62.001.57]

[Abstract] Existing methods for interpolating water temperature, salinity and density of sea water make it possible to compute these characteristics independently of one another, but in nature these parameters are closely interrelated and ignoring this may have a negative effect on the quality of the results. The latter is manifested in a decrease in the spatial gradients of the investigated fields in the zone of ocean fronts and in a displacement of the results into regions of improbable states of the analyzed characteristics. The interpolation method proposed in this article makes possible a considerable decrease in the influence of these negative factors on the final computation results. It was tested using a file of test range observations in the Newfoundland Energy Active Zone collected on the Krenkel scientific research weather ship in November 1986 in a test range consisting of seven runs (15 stations occupied on each) separated by a distance of 1°. Computations were made for the 50-m horizon in two variants: with and without allowance for the interrelationship of the temperature, salinity and density fields. The test results showed that allowance for the joint interpolation results in an increase in the gradients of temperature, salinity and density within the limits of frontal zones. A probabilistic analysis of the constructed computation fields indicated that the effect of joint interpolation made possible a 43 percent decrease in the number of solutions falling in the field of improbable states of the investigated parameters. Figure 1; references: 2 Russian.

### Role of Advective Component in Heat Balance of Black Sea Coastal Zone

927N0138F Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 9 Dec 91) pp 113-117

[Article by S. T. Kaminskiy and N. V. Pribylskaya,  
Experimental Division, Marine Hydrophysics Institute;  
UDC 551.465.73(262.5)]

[Abstract] The advection of heat by currents is presently the most difficult component of the heat balance in the sea to determine because a whole series of dynamic and thermal characteristics of currents must be known. In most cases it is found indirectly as the difference between the heat content of the active layer in the sea ascertained from hydrological data and the quantity of heat ascertained from computations of the external heat balance. The objective of the study was to find such a difference in order to clarify the role of the advective component in the formation and annual variation of the heat content of waters in the coastal zone of the southern coast of the Crimea. The intraannual variability of the advective component is traced and an attempt is made to give both a qualitative and quantitative estimate of the contribution of advection to the heat balance of coastal zone waters. The year 1980 was selected as having the best hydrological and meteorological information. The advective component in the thermal budget of the coastal zone has a positive or negative sign, depending

on season. During the warm season advection is negative. Due to the continuing cooling in June-July in the cold surface layer at depths from 30 to 90 m the increment in heat content in the layer 0-90 m is less than in the layer 0-30 m in which summer heating occurs. In the cold season advection in all layers is positive. During these months advection is ensured not only by a positive heat content in the waters of the coastal zone of the sea, but also by the compensation of heat losses into the atmosphere when there is a negative heat balance at its surface. Figures 3; references: 6 Western.

### Dynamic-Stochastic Model of Assimilation of Remote Measurements of Ocean Surface Temperature

927N0128A Sevastopol MORSKOY  
GIDROFIZICHESKIY ZHURNAL in Russian No 2,  
Mar-Apr 92 (manuscript received 19 Apr 91) pp 17-26

[Article by I. Ye. Timchenko, V. D. Yarin, Ye. F. Vasechkina and V. Yu. Polyanichev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.463:532.14.07(261.5)]

[Abstract] This report represents a further development of earlier research by the authors on the assimilation of remote measurements of ocean surface temperature (Teoreticheskiye issledovaniya okeanicheskoy tsirkulyatsii (Theoretical Research on Ocean Circulation), Sevastopol, pp 47-59, 1984). This problem is now examined by formulation of a three-dimensional model of synoptic variability of the ocean with pertinent two-dimensional integral equations for the upper mixed layer (UML). The position of the UML lower boundary is characterized by two principal dynamic regimes: an entrainment regime in which the boundary is displaced downward, provoking the lower-lying fluid layers into active mixing, and an anti-entrainment regime in which the boundary moves upward and the depth of the mixed layer decreases. After deriving the required system of two-dimensional equations for describing UML movements, an algorithm is written for ocean surface temperature assimilation. This is used in objective determination of the pertinent empirical parameters. It was found that the quality of forecasts is not influenced by the absolute initial values of the coefficients but by the relations between them. Four series of numerical computations are discussed. Computations were made for the assimilation of satellite data registered by a station located in the Guinea Republic. The wind field was computed from the pressure field registered in Guinea and in the Cape Verde Islands. Prognostic computations were made for a period 10 days in advance. There was a satisfactory consistency between the predictions made using the proposed algorithm under the model experiment conditions and "true" (standard) computations. Figures 5; references 8: 6 Russian, 2 Western.



**Influence of Wave Disturbances in Near-Water Layer on Structure of Interacting Atmosphere-Ocean Boundary Layers**

927N0128B Sevastopol MORSKOY  
GIDROFIZICHESKIY ZHURNAL in Russian No 2,  
Mar-Apr 92 (manuscript received 5 May 91) pp 48-54

[Article by V. V. Yefimov and D. E. Terez, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.465.75]

[Abstract] Allowance for the influence of surface waves on the structure of boundary layers is one of the significant difficulties involved in constructing numerical models of interaction of boundary layers. The wave layer is usually regarded as a plane interface. Various proposals have been made for solution of this problem, but all are deficient in one respect or another. A somewhat different approach is therefore used by introducing a subregion of wave stresses into the near-water layer of the atmosphere. The formulated model is one-dimensional and stationary. It is shown that the presence of wave stresses in the lower part of the constant flows results in a corresponding decrease in the turbulent component because total stress is approximately constant. Wave stresses also lead to a decrease in turbulent energy near the surface in the atmosphere. However, the energy accumulated by wave disturbances and then released during wave collapse causes an increase in turbulent energy in the upper part of the oceanic layer. The presence of wave stresses also exerts an influence on the characteristics of interaction between the two media, such as dynamic velocity, roughness parameter and the geostrophic coefficient. A table gives the results of computations for geostrophic velocities in the atmosphere in the presence and absence of wave stresses. Thus, wave disturbances in the near-water layer (energy transfer from the wind to waves) exert a substantial influence on the nature of change in the principal characteristics and parameters of interaction of the two media. Figures 5; references 8: 7 Russian, 1 Western.

**New Type of Instability of Long Waves in Shallow Water: Nonlinear Sign-Variable Viscosity in Tides**

927N0148A Moscow DOKLADY AKADEMII NAUK  
in Russian Vol 323 No 1, Mar 92 (manuscript received  
24 Dec 91) pp 58-61

[Article by S. A. Arsenyev, A. Yu. Gubar, L. N. Rykunov, corresponding member, Russian Academy of Sciences, and N. K. Shelkovnikov, Moscow State University imeni M. V. Lomonosov; UDC 551.466]

[Abstract] Research on the vertical structure of turbulent tidal currents at river mouths revealed that the coefficient of vertical turbulent viscosity assumes negative values during the tidal cycle. Attempts to explain this effect have failed. Theoretical difficulties are attributable to the fact that there is a loss of part of the information embodied in the initial Euler-Reynolds equations when vertical averaging is carried out since in

such averaging it is assumed that horizontal velocity has one degree of freedom, whereas in the solution of these equations in a general case there may be an unlimited number of degrees of freedom of vertical movements. It was found that the Ritz method makes it possible to describe a number of new instability effects in long waves in shallow water, including a recently discovered sign-variable viscosity of tides, and this method was therefore applied in a further examination of the problem. A low-frequency instability was found which is atypical for ordinary negative viscosity and represents an essentially new nonlinear sign-variable viscosity effect. The newly discovered type of viscosity also causes a HF instability of long waves. References 12: 10 Russian, 2 Western.

**Analysis of Surface Temperature of World Ocean**

927N0141A Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 2, Feb 92 (manuscript  
received 4 Jun 91) pp 60-65

[Article by D. A. Larin, Institute of Global Climate and Ecology, Russian Federation Committee for Hydrometeorology, Russian Academy of Sciences; UDC 551.465.62.001.57(26)]

[Abstract] The Section on Climate Dynamics of the Institute of Global Climate and Ecology developed a scheme for the analysis of ocean surface temperature (OST) which makes possible an analysis for any region of the world ocean and also for the world ocean as a whole. Since shipboard observations do not ensure adequate coverage, especially for the southern hemisphere, a study was made of the possibility of supplementing shipboard data with satellite information. The different types of shipboard measurements and the methods used in their processing and checking are reviewed, discussed in individual sections and evaluated. A table gives some statistical characteristics of approximation errors for six individual regions of the world ocean. The rms approximation errors are usually 0.3-0.4°C. SATEM (satellite) data for 25-30 November 1989 for the Atlantic Ocean were compared with data from SHIP and DRIBU (surface) telegrams. OST data based on ship and satellite data were analyzed separately. The differences in the analyses, averaged by latitude zones, are presented. The discrepancies are quite great and vary significantly as a function of latitude. The direct joint use of satellite and shipboard data is therefore impossible and this requires that specialized procedures be developed. Figures 2; references 6: 2 Russian, 4 Western.

**Ship Waves in Continuously Stratified Basin With Ice Cover**

927N0143A Sevastopol MORSKOY  
GIDROFIZICHESKIY ZHURNAL in Russian No 1,  
Jan-Feb 92 (manuscript received 22 Jan 91) pp 10-18

[Article by A. Ye. Bukatov and V. V. Zharkov; Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 532.593:539.3:624.131]

[Abstract] The author previously investigated internal waves during movement of a plane front through ice in a fluid with a density jump (MOR. GIDROFIZ. ISSLED., No 2, pp 15-26, 1977) and later in an axisymmetric region of pressures (IZV. AN SSSR. MZhG, No 1, pp 85-91, 1990). Continuing this field of research, drawing on the previous work and other sources, a study is made in a linear formulation of ship waves generated in an exponentially stratified fluid during movement of an axisymmetric region of pressures of a constant intensity through a floating ice cover. The influence of ice rigidity on the distribution of the amplitudes of internal wave disturbances along lines of equal phase are analyzed. Figures 1-4 show: lines of constant phase of internal waves of the first and second modes; zones of wave disturbances caused by the first and second modes; amplitude distribution of internal waves of the first mode along lines of equal phase; amplitude distribution of internal waves of the second mode along lines of equal phase. These figures are fully discussed in the text. Under given conditions ice introduces no qualitative changes into the nature of amplitude distribution of manifestations of either longitudinal or transverse internal waves along the crests (troughs) on the basin surface. An increase in the weight of the load and the vertical temperature gradient results in an increase in the amplitudes of manifestation of internal waves. Broken ice exerts no significant influence on the structure and amplitude of internal waves. Figures 4; references 9: 7 Russian, 2 Western.

#### Estimating Rate of Upwelling of Black Sea Deep Waters From Vertical Distribution of Hydrogen Sulfide

927N0143B Sevastopol MORSKOY  
GIDROFIZICHESKIY ZHURNAL in Russian No 1,  
Jan-Feb 92 (manuscript received 4 Oct 91) pp 78-80

[Article by L. V. Yeremeyeva and A. Kh. Degterev,  
Marine Hydrophysics Institute, Ukrainian Academy of  
Sciences, Sevastopol; UDC 551.465]

[Abstract] In order to solve many problems related to prediction of the state of the Black Sea it is important to know the rate of vertical mixing in its abyssal part. An analysis of the vertical distribution of the concentration of some dissolved gases such as hydrogen sulfide or methane shows that below 1000 m their concentration changes slightly with depth. This is indicative of an advective mechanism of vertical mixing since a diffusion mechanism assumes the presence of a concentration gradient. In the deep layers of the Black Sea the advective mechanism of vertical mixing predominates not only with respect to the quantity of transported hydrogen sulfide, but also with respect to the time during which the hydrogen sulfide rises from a depth 2000 m to a

depth 1000 m. With rising at a rate  $10^{-4}$  cm/s about 30 years is expended on this process, whereas turbulent transport with  $K = 2$  cm<sup>2</sup>/s requires 150 years. By such calculations it also is possible to estimate the age of the hydrogen sulfide in Black Sea waters, which is important for predicting evolution of hydrogen sulfide pollution in the sea. Deeper than 1000 m there is relatively young hydrogen sulfide with an age not greater than 30 years. However, at the boundary with the oxygen layer hydrogen sulfide is oxidized which was formed approximately 150 years ago. References: 6 Russian.

#### Observation of Surface Wave Refraction in Gulf Stream

927N0147A Moscow DOKLADY AKADEMII NAUK  
in Russian No 6, Jan 92 (manuscript received 13 Dec  
91) pp 1162-1167

[Article by S. A. Grodskiy, V. A. Dulov and V. N. Kudryavtsev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.465.5+551.466]

[Abstract] The interaction between waves and a current can considerably increase their energy and constitute a danger for navigation. A special class of waves, trapped waves, is possible in currents of the jet type. The concentration of their energy in the current zone is the probable cause of ship accidents near Cape Agulhas. However, such trapped waves evidently have never been studied experimentally. This article describes observations of wave evolution in the Gulf Stream, especially trapped waves. The experiment was carried out in August-September 1991 aboard the Vityaz research ship. The ship intersected the current in a direction perpendicular to the frontal zone. The following parameters were registered: velocity component of the surface current perpendicular to the course; vertical hydrological structure at three-mile intervals to a depth of 300 m; air and water temperature; wind speed and direction; fraction of the sea surface covered by whitecaps; radar image of surface waves with a resolution  $10 \times 10$  m; amplitude of ship's rolling. Information is given on one of 27 Gulf Stream intersections for which the effects of the current on waves are most clearly expressed. Two systems of surface waves were observed in the experiment: those passing through the current and those trapped by it. The variability of the wave number of the spectral peak of the waves passing through the current corresponded to ray concepts concerning the evolution of wave packets in a current. The trapped system was localized precisely in the wave guide region determined from the same theoretical concepts. An intensification of energy-bearing waves and a breaking of wind waves were observed in the wave guide region. Figures 3; references 6: 5 Russian, 1 Western.

### Features of Light Pulse Propagation in Turbid Medium With Slant Incidence of Beam on Its Boundary

927N0119B Moscow IZVESTIYA AKADEMII NAUK RAN: FIZIKA ATMOSFERY I OKEANA in Russian Vol 28 No 6, Jun 92 (manuscript received 22 Aug 91) pp 599-603

[Article by A. V. Aistov and V. G. Gavrilenko, Nizhegorod University; UDC 551.463.5]

[Abstract] It is shown that absorption most strongly distorts some averaged parameters of pulsed radiation in the case of large angles of incidence of a light beam on the boundary of a randomly inhomogeneous medium (most such studies have been devoted to the case of incidence of a light pulse propagating along the normal to the boundary of a medium). These effects are analyzed by solving the transfer equation by the small-angle approximation method proposed earlier by Gavrilenko and extended to a nonstationary case. A simple expression is derived for time-dependent ray intensity which remains correct to depths at which a strong reorganization of beam structure begins, characterized by a considerable deflection of the direction of propagation from the direction of the rays refracted on the boundary. It was found that pulse duration in the depths of a medium, measured by an elongated detector, may increase considerably due to absorption. The effect of a decrease in the arrival time of the signal energy maximum in comparison with a nonabsorbing and nonscattering medium can be attributed to an increase in the probability of absorption of photons travelling a greater path. An increase in arrival time scatter is a direct consequence of the effective section of the beam by the plane  $z = \text{const}$ , caused, in turn, by an anomalously rapid increase in the angular divergence of radiation with depth with slant irradiation of the boundary of an absorbing randomly inhomogeneous medium. The effect of an anomalously rapid increase in arrival time scatter of radiation at a stipulated depth can be observed in the real ocean because the spectral indices of sea water scattering fully satisfy the restrictions imposed on the nature of single scattering. References: 11 Russian.

### Relationship Between Zones of Radar Signal Attenuation and Convergence of Surface Currents

927N0124A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 92 (manuscript received 25 Jun 91) pp 10-15

[Article by S. A. Grodskiy, V. A. Dulov and V. N. Kudryavtsev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 528.88.044.1:551.465]

[Abstract] A study was made of the possible reasons for the redistribution of the concentration of surfactants by the field of surface currents. In order to clarify this matter a number of test range surveys were made in 1988 from aboard the Professor Kolesnikov survey ship.

Other observations were made using an airborne radar with continuous measurements of the backscattering section; a radar navigation outfit also was employed. The radar signal strength was proportional to the spectral density of the Bragg component of ripples. These measurements of radar backscatter from an aircraft under conditions of prevalence of weak winds in the north-western part of the Black Sea revealed the existence of zones of a radar signal minimum which can be interpreted as zones of increased concentration of surfactants. These zones fall in the region of surface current convergence and move along together with the convergence region. The presence of a relationship between convergence regions and zones of increased concentration of surfactants, demonstrated by the shipboard and aerial radar observations, can be used in a rough prediction of the propagation of pollutants over the sea surface because the averaged position of convergence zones is usually known. On the other hand, the registry of zones of increased concentration of surfactants from an aircraft can be useful in ongoing monitoring of the movement of convergence zones. Figures 3; references 8: 7 Russian, 1 Western.

### Methods for Solving Phase Problem in Digital Image Processing. Part I. Theoretical Problems. Phase Problem

927N0129A Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 5 No 5, May 92 (manuscript received 24 Jan 92) pp 472-479

[Article by P. A. Bakut, A. A. Pakhomov and A. D. Ryakhin, Astrofizika Scientific Production Association, Moscow; UDC 535.317.1]

[Abstract] The phase problem has received much attention since the early 1950's and many theoretical examinations and specific retrieval schemes have been published, but there has never been a detailed, comprehensive analysis of the two-dimensional phase problem, especially for discrete distributions. There also has been no fast and stable retrieval algorithm suitable for these purposes. Both known and original results are therefore used in filling these gaps and examining these matters applicable to the most important practical field of applicability: digital processing of optical images. This study consists of three parts in this same number of the journal (Part II—pp 480-487, Part II—pp 488-496). In this first part particular attention is given to uniqueness of solution of the phase problem in one- and multidimensional cases. The difference between the one- and multidimensional cases is fully clarified and the success in experiments with numerical solution of the two-dimensional case is explained. A general method for reducing a two-dimensional discrete case to a one-dimensional case is proposed, as well as procedures for constructing all the solutions for a two-dimensional discrete case. A full algorithm is outlined for solving this problem. References 22: 3 Russian, 19 Western.

### Methods for Solving Phase Problem in Digital Image Processing. Part II. Analytic Methods for Solving Phase Problem

927N0129B Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 5, May 92 (manuscript received 24 Jan 92) pp 480-487

[Article by P. A. Bakut, A. A. Pakhomov and A. D. Ryakhin, Astrofizika Scientific Production Association, Moscow; UDC 535.317.1]

[Abstract] A general analysis of uniqueness of solution of the phase problem (given in Part I of this three-part study, pp 472-479 in this journal) indicates that it can be solved unambiguously if the unknown retrievable distribution (image) is representable (one-dimensional case) or initially (two-dimensional case) is a contraction of two or more images. In order to ensure uniqueness in the retrieval it is necessary in this situation to draw upon additional information, as which it is most natural to use preliminary exponential image filtering. The exponent "penetrates" under the integral of the contraction and the filtered contraction is equal to the contraction of the exponentially filtered images. Exponential filtering also is necessary in constructing analytic solutions using Hilbert transforms because it "shifts" the zone of the roots in the complex plane and makes it possible to establish a unique relationship between the modulus and phase. With these considerations taken into account, the adequate conditions are determined for a unique solution of the phase problem. A generalization of the Hilbert equations is given for a two-dimensional discrete case and the uniqueness of the solution in a two-dimensional continuous case is examined. Figure 1; references 11: 7 Russian, 4 Western.

### Methods for Solving Phase Problem in Digital Image Processing. Part III. Retrieval Algorithms

927N0129C Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 5, May 92 (manuscript received 24 Jan 92) pp 488-496

[Article by P. A. Bakut, A. A. Pakhomov, A. D. Ryakhin and I. P. Plotnikov, Astrofizika Scientific Production Association, Moscow; UDC 535.317.1]

[Abstract] As was demonstrated in Part II of this three-part study (pp 488-496 in this number of the journal), analytic solutions of the phase problem are possible for a rather narrow class of images, and in particular, those having a point source in its distribution. A number of algorithms for solution of this problem have been published and their strengths and shortcomings are fully examined. The best are those based on solution of the autocorrelation equation by iterations, including one for an approximate solution. An algorithm embodying the best characteristics of those already proposed is outlined. A method is given for determining the minimum number of readings adequate for retrieval and a theoretical and practical analysis of noise immunity is presented. The practical application of the algorithm is

illustrated in an example. The correctness of the selected iteration retrieval method, making it possible to obtain an approximate solution in the absence of a precise solution, is confirmed. Figures 2; references 16: 4 Russian, 12 Western.

### Efficiency of Wind Speed Lidar Measurements by Correlation Lidar

927N0129D Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 5, May 92 (manuscript received 31 Jan 92) pp 497-503

[Article by V. G. Astafurov, E. Yu. Ignatova and G. G. Matviyenko; UDC 551.521]

[Abstract] The laser sounding method is highly promising for measuring wind parameters. Its merits include simplicity in the reception and processing of information, low requirements on the laser transmitter in comparison with a coherent Doppler lidar, efficacy and a high spatial-temporal resolution of the registered information. However, the possibilities of the correlation method are limited to a considerable degree by fluctuations in transparency to the scattering volumes, the low contrast of aerosol inhomogeneities and their variability. An analysis was made to determine the influence of these factors, as well as fluctuations of signals and noise, on the efficiency in measuring wind speed by a correlation lidar. By "efficiency" is meant the relation between the error in determining the wind and atmospheric factors (parameters of spatial-temporal fluctuations of aerosol scattering coefficients, wind speed field pulsations, transparency fluctuations, background illumination) and instrumental factors (noise, observation time, laser transmitter pulse repetition rate and power). A suboptimal estimate of wind speed was made by the spectral processing of lidar signals. The error in this estimate was found and it was computed as a function of atmospheric conditions and instrument parameters for experimentally validated models of correlation functions of lidar signals. Recommendations are given on the choice of parameters for a two-path sounding scheme with allowance for the time of evolution of aerosol inhomogeneities. Figures 4; references: 10 Russian.

### Retrieval of Laser Beam Parameters From Temperature Field of Heated Surface

927N0129E Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 5, May 92 (manuscript received 16 Jan 92) pp 509-516

[Article by V. P. Aksenov and Yu. N. Isayev, Atmospheric Optics Institute, Siberian Department, Russian Academy of Sciences, Tomsk; UDC (535.2+535.241): 621.373]

[Abstract] In an earlier published article (OPTIKA ATMOSFERI I OKEANA, Vol 4, No 2, pp 166-172, 1991) the author found a solution for the problem of measuring the intensity distribution  $I(\rho, t)$  in the section

of powerful laser beams by retrieving intensity on the basis of measurements of the temperature field  $T(p, t)$  of a heated surface. In that study the multidimensional spatial-temporal inverse problem, to whose solution the retrieval problem is reduced in a general case, was transformed to a one-dimensional problem by choice of a "one-dimensional" target of a special design. Continuing this research, analytic solutions of the three-dimensional spatial-temporal inverse problem of thermal conductivity (the problem of scaling of boundary conditions) are obtained. In contrast to the earlier study, a uniform plate was selected as the target. Appropriate dynamic expressions are derived for retrieving the spatial-temporal intensity distribution, the instantaneous position of the center of gravity, effective size and functional of laser beam focusing with arbitrary boundary conditions on the reverse surface of the plate. Insofar as is known, this is the first time that an analytic solution of this problem has been found in a multidimensional formulation. References: 5 Russian.

#### **Lidar Temperature Measurements of Upper Stratosphere**

927N0109B Moscow IZVESTIYA AKADEMII NAUK  
RAN: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 28 No 5, May 92 (manuscript received 4 Mar 91,  
after revision 27 Nov 91) pp 506-511

[Article by O. K. Kostko, S. S. Khmelevtsov and G. A. Kalyagina, Tayfun Scientific Production Association; Sovintervod Production Association; UDC 551.501.816]

[Abstract] Several methods for determining stratospheric temperatures by lidars are discussed, but this article emphasizes a new method based on use of the equation of state and the hydrostatics equation. In the method described there is no need for complex spectral receiving apparatus and lasers with additional devices ensuring special radiation parameters. The instrumentation and method are described in detail. The accuracy in determining temperature of the upper stratosphere when using the lidar-measured density profile is evaluated. The maximum possible accuracy in determining temperature is discussed. Several tens of measurements of the vertical profiles of atmospheric density and temperature were made by the described method at Obninsk station in 1989 and 1990. A standard "Maket-1" network lidar was used in making regular measurements of the parameters of stratospheric aerosol. The completely automated lidar was supplied with a standard YAG laser radiating pulses with a wavelength 532 nm and a pulse power 40 mJ at a frequency 25 Hz. Some of the results are given. The considerable intraseasonal changes (warmings and coolings) observed in the vertical structure of the atmosphere must be taken into account when standardizing the thermodynamic atmospheric parameters and therefore the considered method and apparatus can be used primarily in determining intraseasonal temperature variability. Figures 3; references 12: 4 Russian, 8 Western.

#### **Evaluation of Cloud Resources for Dispersal Over USSR Territory**

927N0138A Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 17 Sep 91) pp 20-27

[Article by L. K. Belova, I. V. Litvinov and V. G. Tsverava, Tayfun Scientific Production Association; UDC 551.509.616(47+57)]

[Abstract] An analysis of the completeness and quality of the archives of meteorological observations made eight times a day indicated that such materials can be used in a quite correct evaluation of the precipitation-yielding potential of clouds suitable for dispersal over the territory of the country. The absolute  $N_{dis}$  and relative ( $Q$ ) quantities of such cloud resources were computed using data for each of 220 meteorological stations. The results of  $N_{dis}$  and  $Q$  computations were mapped (Fig. 1 and 2). A distinctive feature of these two fields is that over the greater part of the country they have a very complex structure; there is no real pattern. The  $N_{dis}$  values over most of the country are from 400 to 800 hours per year.  $N_{dis}$  values greater than 1000 hours are annually observed as individual foci in the northwestern European USSR, in Irkutsk Oblast and in southwestern Kamchatka. Regions of low  $N_{dis}$  values (200 hours annually or less) for the most part occupy the southern margins of the Central Asian republics, eastern regions of Amur Oblast and the southern part of Khabarovsk Krai. With respect to  $Q$ , its highest values (2.0-2.2) are in the west and northwest of the European USSR. In Kazakhstan, republics of Central Asia and over most of Western Siberia  $Q$  varies from 1.15 to 1.35. East of the Yenisey the  $Q$  values are usually 1.4-1.6. Figures 2; references: 17 Russian.

#### **Climatic Monitoring of Virtual Heat Exchange Between Earth's Oceans and Atmosphere**

927N0138E Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 4, Apr 92 (manuscript  
received 30 Jul 91) pp 102-104

[Article by B. A. Birman and T. G. Pozdnyakova, Hydrometeorological Scientific Research Center, Russian Federation; UDC 551.465.7:551.5]

[Abstract] An archives of data on the mean monthly values of turbulent heat exchange and its components in a grid  $5 \times 5^\circ$  for the period 1957-1990 has been organized at the USSR Hydrometeorological Center. Since 1991 the available series and climatic statistics and on-line data arriving through communication channels in the SHIP code have been used in regular monitoring of virtual heat exchange between the oceans and atmosphere in the northern hemisphere. The results for 1986-1990 are given. The total turbulent heat flows from the ocean to the atmosphere ( $P + LE$ ) for this period for the Atlantic and Pacific Oceans were greater than the norm by 6 and 19 percent respectively. The highest values were observed in 1990: 134 W/m<sup>2</sup> in the Atlantic and 144

$W/m^2$  in the Pacific, 11 and 21 percent greater than the norm respectively. A figure shows the spatial-temporal variability of  $P + LE$  anomalies; a second figure shows the year-to-year  $P + LE$  changes during 1957-1990. In general, the level of heat exchange between the Atlantic Ocean and the atmosphere in the northern hemisphere changed insignificantly over a period of 34 years. In the Pacific Ocean, despite a general increase in heat exchange, there were periods of substantial decrease (1966-1967 and especially 1982-1985). Figures 2; references 13: 11 Russian, 2 Western.

### **Intensity Distribution in Image Plane of Point Reflector With Arbitrary Angular Position on Turbulent Sounding Path**

927N0130A Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 4, Apr 92 (manuscript received 27 Jun 91) pp 388-390

[Article by P. A. Bakut and S. V. Shults, Astrofizika Scientific Production Association, Moscow; UDC 535.42]

[Abstract] The correlation of incident and reflected waves in the case of double passage of radiation through the very same inhomogeneities of a turbulent atmosphere results in an intensification of backscattering and a doubling of the dispersion of phase fluctuations of the reflected wave. With a displacement of the reflector from the axis of the directional diagram of the emitter the correlation of the counter waves causes a bias of the evaluation of the angular position of the reflector. Special cases of this problem are examined in detail: when the radiating and receiving apertures are matched and when they are mismatched. The ramifications of such a difference are examined. An approximate analytic expression is obtained for the observed bias. An intensification of backscattering is accompanied by an increase in the bias of the evaluation. Some threshold value exists at which the amplification factor  $N$  begins to increase rapidly, that is, the maximum of the distribution of mean intensity in the case of a turbulent medium drops off far more slowly than in the case of a homogeneous medium. Figures 2; references: 4 Russian.

### **Resonance Self-Focusing Accompanying Laser-Induced Disparity in Velocity Distribution of Gas Molecules**

927N0130B Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 4, Apr 92 (manuscript received 11 Nov 91) pp 408-412

[Article by A. E. Bazelyan, S. V. Ivanov, M. N. Kogan and V. Ya. Panchenko, Scientific Research Center for Industrial Lasers, Russian Academy of Sciences, Troitsk; Central Aerohydrodynamic Institute imeni Prof. N. Ye. Zhukovskiy, Zhukovskiy; UDC 533.6.011:621.373.826.038.823]

[Abstract] An analysis of resonance self-focusing of the velocity distribution of molecules is possible by several methods, but a quantitative description of laser-induced disparity of velocities in molecular gases requires use of a more complex kinetic model. In order to rectify this shortcoming curves of the anomalous dispersion of a small impurity of molecular gas are computed in a medium of buffer gas under conditions when there are laser-induced distortions of the Maxwellian velocity distributions of molecules at resonance molecular levels. It is shown that such distortions may increase by several times the absolute values of refractive index change. The result is essentially dependent on the relation of the velocities of elastic (T-T) and rotational (R-T) molecular relaxation. In the limiting case of slow elastic relaxation a simple formula is derived for the refractive index and the limits of its applicability are analyzed. With allowance for the laser-induced distortions of the Maxwellian distributions estimates are made of the resonance self-focusing parameter for the radiation of a  $Co_2$  laser in the atmosphere. Figures 2; references 13: 10 Russian, 3 Western.

### **Single-Frequency Laser Sounding of Stratospheric Ozone Layer**

927N0130C Tomsk OPTIKA ATMOSFERI I OKEANA in Russian Vol 5 No 4, Apr 92 (manuscript received 24 Oct 91) pp 418-423

[Article by O. K. Kostko, S. S. Khmelevtsov, Yu. G. Kaufman, Ye. A. Svetogorov and G. A. Kalyagina, Tayfun Scientific Production Association, Obninsk; Sovintervod Production Association, Moscow; UDC 551.591]

[Abstract] Measurements of stratospheric ozone were made at an altitude 20-30 km using a single-frequency lidar. The lidar receiving system was a Newtonian type telescope with a spherical mirror with a diameter 70 cm and a focal length 235 cm. The errors in determining ozone concentration were determined as the sum of the errors due to fluctuations in the number of registered photoelectrons, inaccuracy in knowledge of atmospheric density at the sounding levels and inaccuracy in knowledge of distance to the corresponding layers. Since the ozone is determined in the best case with an error 5-10 percent a single-frequency lidar can be used in determining artificial agents exerting an influence on the ozone layer. A specially developed lidar ozonometer was used in measuring the ozone concentration distribution. The excimer laser employed radiates at a wavelength 308 nm. The divergence of radiation does not exceed 0.5 mrad, which makes it possible to dispense with a collimating system. Pulse power is about 70 mJ and pulse repetition rate is up to 50 Hz. The structure and functioning of the entire system are described in some detail, but no block diagram is provided. Some results obtained using this outfit in 1990 are illustrated. Figures 2; references 3: 2 Russian, 1 Western.

**Irradiance Structure in Image Plane in Lidar Sounding of Surface in the Atmosphere With a Complex Scattering Phase Function**

927N0130D Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 5 No 4, Apr 92 (manuscript received 19 Oct 91) pp 424-427

[Article by M. L. Belov and V. M. Orlov, All-Union Scientific Research Institute of Marine Fishing and Oceanography, Moscow; UDC 551.501]

[Abstract] The distribution of irradiance in the image plane of a lidar receiver was determined when sounding a surface in the atmosphere with a complex scattering phase function. From the brightness distribution on a scattering surface it is possible to determine the brightness of radiation incident on the detector and the irradiance distribution in the image plane of the detector. Proceeding on this basis, an expression is derived for irradiance in the image plane when sounding through an optically dense aerosol atmosphere a surface with a scattering phase function having diffuse and quasimirror components. It was found that the relation of the quasimirror and diffuse components of the scattering phase function for the sounded surface exerts a considerable influence on the distribution of irradiance in the image plane at reception angles close to mirror angles. Atmospheric turbidity results in an increase in the size of the image (due to an increase in the illuminated spot on the scattering surface) and a relative (in comparison with the size of the entire image) decrease in the region on the image where a significant contribution to the echo signal is made by the quasimirror component of the surface scattering phase function. Figures 2; references: 8 Russian.

**Evaluation of Imagery Properties and Interpretation Possibilities of Digital Terrain Images**

927N0123A Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 92 pp 39-41

[Article by N. N. Zinchuk, V. A. Moroz, I. Yu. Shevchenko and O. A. Korkova; UDC 528.871]

[Abstract] A more precise approach is proposed for evaluating the possibilities for interpretation of digital terrain images when using nonphotographic (optoelectronic) survey systems. The point of departure is the work done by K. Szangolies in VERMESSUNGSTECHNIK, No 3, S 96, 1987. Expressions are derived for taking into account the results of visual interpretation of the imagery, making allowance for all pertinent interpretation factors. These formulas, modified with allowance for the "spatial resolution" factor, make it possible to evaluate the theoretically attainable level of probability of recognition of terrain features from digital images. The results of a priori and a posteriori evaluations of the interpretation possibilities of digital images are presented. A table summarizes the required operations and pertinent parameters. A comparison of the computed

and actual interpretation results indicates the great importance of evaluating the interpretation possibilities of digital terrain images using the "spatial resolution" factor as a critical consideration. The proposed approach to an analysis of the properties of materials obtained by remote optoelectronic survey systems is not limited to cartographic work, but can be used in other geographical research fields as well. References 3: 2 Russian, 1 Western.

**Artificial Enhancement of Precipitation From Convective Clouds in Tropical Zone and Lowland Regions of European USSR**

927N0137A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 3, Mar 92 (manuscript received 20 Sep 91) pp 41-50

[Article by B. I. Zimin, V. P. Koloskov, Yu. A. Seregin and A. A. Chernikov, Central Aerological Observatory; UDC 551.509.616/617(213.5+47)]

[Abstract] The results of experiments for artificial modification of isolated convective clouds and cloud clusters in two greatly differing areas are presented. The work was carried out in the Camaguey meteorological test range (Cuba) in 1985-1988 and in the Penza test range (USSR) in 1983-1989. It was found that the reaction of convective clouds to seeding with an ice-forming reagent is dependent on their development stage and cloud structure. Test criteria were defined for determining the suitability of clouds for seeding with an ice-forming reagent for obtaining additional precipitation. In general, the clouds suitable for seeding are growing clouds with temperatures at the upper boundary -10...-20°C and with a diameter of the cloud tops from 2 to 5 km for continental clouds in the temperate latitudes (Penza test range). The seeding of such clouds is accompanied by a great increase in the upper cloud boundary, an increase in cloud lifetime and area and with more than a doubling of precipitation. Isolated convective clouds yielded about 3 percent of the total quantity of precipitation in the Camaguey (tropical) test range, but cloud clusters yielded about 20-25 percent. It is therefore clear that clusters are preferable seeding targets for enhancing precipitation over the area of that test range. Figures 3; references: 9 Russian.

**Research on Atmospheric Boundary Layer Over Ocean Using Captive Balloon**

927N0137B Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 3, Mar 92 (manuscript received 4 Apr 91) pp 51-56

[Article by O. G. Vystavkin, S. K. Gulev, V. S. Loboda, V. S. Melekhin, Ye. B. Tonkachev, S. M. Shepelenko and S. V. Yakhimuk, State Oceanographic Institute; UDC 551.507.321.4:551.510.522]

[Abstract] Balloon research was carried out during the "Atlantex" experiment in the Newfoundland Energy



Active Zone on the scientific research weather ships Viktor Bugayev and Volna during the period February-May 1990. The apparatus used consisted of a captive balloon, equipment for its ascent and recovery (electromechanical winch, steel six-strand cable 0.9 mm in diameter with a length 500 m weighing 2.8 kg), a balloon probe (developed on the basis of an MARZ-2-1 radio-sonde) and a "Meteorit" radar. Envelopes with a volume 6 m<sup>3</sup> and a length 6 m were used. The balloons could carry aloft a payload of 1.5 kg to an altitude 500 m. The admissible relative wind speed during launching and landing cannot exceed 10 m/s, but after gathering altitude it can be 15-20 m/s. Two types of probes were used, the second differing in having a special pressure sensor. Soundings were made during times when the ships passed through the subpolar hydrological front. About 150 soundings of the atmospheric boundary layer (ABL) were made. The balloons can be used in studying processes with time scales greater than 20 minutes, horizontal processes with a scale greater than 3-5 km and vertical processes with a scale greater than 10 m, providing a qualitatively different level of detail in comparison with standard aerological measurements. The balloon data made possible quite good identification of inversion structures, the formation of advection fogs to the north of the subtropical front during air transport from the south and other characteristics of the ABL. Figures 2; references 11: 6 Russian, 5 Western.

#### **Possibilities of Evaluating Degree of Wind Field Nonuniformity Using Measurements With Circular-Scan Doppler Radar**

927N0137C Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 3, Mar 92 (manuscript received 19 Nov 90) pp 110-113

[Article by V. M. Vostrenkov and M. B. Pinskiy, Central Aerological Observatory; UDC 551.501.815:551.55]

[Abstract] A Doppler meteorological radar makes it possible to measure the profiles of wind speed and direction and horizontal divergence. However, with the traditional approach used in processing such Doppler data important information on the spatial nonuniformity of wind field structure is lost. The lost information should be manifested in the presence of higher harmonics of the pertinent function. The higher coefficients of expansion of this function in a Fourier series can serve as a measure of such nonuniformity. Proceeding on this basis, a method is developed for evaluating the degree of nonuniformity of the wind field under different meteorological conditions using data from a single circular-scan Doppler radar. The maximum admissible measurement errors with which the evaluations of the degree of nonuniformity of the wind field are statistically correct are computed. An original method is proposed for eliminating the ambiguity of Doppler measurements of wind speed arising when using pulsed Doppler radars. The estimates will be physically correct when the speeds

related to wind field nonuniformity in order of magnitude exceed tens of meters per second. Such measurements can be made when there are extended zones of precipitation, such as during passage of frontal cloud systems. Figures 3; references: 3 Russian.

#### **Determining Coordinates of Artificial Space Objects by Radiointerferometry Method**

927N0110A Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 5, Sep-Oct 91 (manuscript received 25 Apr 90) pp 25-30

[Article by G. A. Shanurov, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.063.1:629.783]

[Abstract] Fundamental analytic expressions relating the equatorial coordinates of a distant space vehicle with the time lag and interference frequency values measured by the very long base radiointerferometry method are derived on the assumption that the geocentric coordinates of the tracking stations, coordinates of the pole, quasars, etc. are known. If only the time lag is measured it is necessary to use an interferometer made up of not less than two bases. The most advantageous configuration is orthogonal bases of the greatest possible length oriented perpendicular to the direction to the spacecraft. When measuring only the interference frequency it is advantageous to have a base of the greatest possible length oriented along a parallel. The declination of near-equatorial spacecraft is not determined; the accuracy in determining declination increases with an increase in declination. In such a case it is best to observe a spacecraft when the direction to it is perpendicular to the interferometer base. When measuring interference frequency it is feasible to determine only spacecraft declination. The spacecraft coordinates can be determined in the case of an adequately great declination from observations only on a single base oriented along a parallel. For determining the declination of a near-equatorial spacecraft it is necessary to measure the time lag using an interferometer with a base parallel to a meridian. The errors in determining spacecraft coordinates in these different variants are evaluated. Figure 1; references: 5 Russian.

#### **Approximation of Results of Geodetic Control Surveys Used in Erecting High Framework of Structure**

927N0110B Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 5, Sep-Oct 91 (manuscript received 15 Apr 91) pp 30-36

[Article by A. N. Sukhov, candidate of technical sciences, Moscow Land Surveying Institute; UDC 528.48]



[Abstract] The results of geodetic engineering measurements by nature are nonuniform records of some random process. This has practical implications for geodetic work at a construction site. Some of the resultant problems are discussed, applicable, in particular, to the erection of the framework of tall structures. For example, a solution is required for approximation of the record of nonequiprecise geodetic engineering measurements. Such a solution is required because the errors in nonequiprecise measurements may considerably distort the approximation results, especially at the ends of empirical records. The problem is further complicated by the fact that the assignment of weights is dependent on the nature of accumulation of measurement errors in different intervals of the record and on the choice of the approximating function. A solution of the problem of approximation of nonequiprecise measurements by use of a modified Chebyshev polynomial is examined as applicable to engineering metrology. The problem of smoothing of the random process is solved by use of the harmonic analysis method with a validation of the necessary number of harmonics. The smoothing problem is reduced to computation of the coefficients of a polynomial which can be represented in the form of the sum of polynomials of increasing degrees. A practical example of the computations is given. Figure 1; references: 2 Russian.

#### **Methods for Determining Atmospheric Correction in Radio Range Finder Measurements on Slant Paths**

927N0110C Moscow *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA* in Russian No 5, Sep-Oct 91 (manuscript received 6 Mar 89) pp 36-43

[Article by A. S. Medovikov, docent, candidate of technical sciences, V. A. Lykov, engineer, P. Ye. Shirokov, assistant, and N. Ye. Kondratyeva, candidate of technical sciences, Vladimir Polytechnic Institute; UDC 528.021.6]

[Abstract] When measuring distances by airborne radio-geodetic systems allowance must be made for influence of the atmosphere by determining the mean integral refractive index of air along the propagation trajectory of electromagnetic waves. Different methods can be used for determining the required atmospheric correction  $\Delta L$ . Three methods are examined for determining  $\Delta L$ : homogeneous atmosphere, biexponential model of atmosphere and numerical integration method based on results of radiosonde observations. The proposed determination of the altitude of a homogeneous model of the atmosphere makes it possible to compute range corrections differing from the most precise method for determining corrections (by numerical integration using the results of radiosonde observations) by less than 70 cm

when  $Z > 89^\circ$ . The biexponential atmospheric model method makes it possible to obtain range corrections differing from the numerical integration method by less than 74 cm when  $Z > 89^\circ$ ; this difference has a positive sign in comparison with the homogeneous atmospheric model method. The mean range correction value obtained by the homogeneous and biexponential atmospheric models methods are closest to the correction obtained by numerical integration. A combination of these methods makes it possible to introduce range corrections without making atmospheric radiosonde observations. Figure 1; references: 5 Russian.

#### **A Priori Evaluation of Accuracy in Determining Distances Between Surface Points From Measured Topocentric Ranges and Radial Velocities of Artificial Earth Satellites**

927N0110D Moscow *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA* in Russian No 5, Sep-Oct 91 (manuscript received 4 Feb 91) pp 83-91

[Article by V. I. Krylov, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.021:629.783]

[Abstract] In solving some problems in geodesy and geodynamics it is important to determine the internal geometry of the construction, such as the relative position of points on the Earth's surface. One of these problems is determining the length of surface chords. This problem has been solved by synchronous measurements of the topocentric ranges to at least six instantaneous satellite positions or the topocentric ranges and radial velocities to three instantaneous satellite positions from four observation stations. Such procedures have been hindered because it was difficult to ensure synchronous observations, but this problem has now been overcome by the introduction of highly precise radionavigation system. The accuracies in determining the lengths of surface chords from synchronous observations of the topocentric ranges and radial velocities of artificial earth satellites can now be precomputed by the procedures proposed in this article. The problem is solved in models in a local coordinate system. No more than one iteration is required for a final solution in all the considered variants. For the three investigated orbits with four stipulated surface points it was found that the rms errors in the coordinates of points in a local coordinate system are comparable in magnitude to the true errors in the coordinates of the points. The rms errors in measuring ranges are commensurable with the rms errors in the coordinates of the points. The accuracy in determining the position of surface points is essentially dependent on the number of observations. References: 2 Russian.

**Evaluation of Accuracy in Functions of Adjusted Quantities in Adjustment of Surface Geodetic Network With Allowance for Satellite Data**

927N0110E Moscow IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: GEODEZIYA I  
AEROFOTOSYEMKA in Russian No 5, Sep-Oct 91  
(manuscript received 15 Feb 91) pp 91-100

[Article by Kha Min Khoa (Socialist Republic of Vietnam), graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.1:528.3]

[Abstract] Although there are now a number of studies on the joint adjustment of surface and satellite geodetic networks and on the adjustment of a surface geodetic network with allowance for the results of adjustment of a satellite geodetic network, in recent studies little attention has been given to evaluation of the accuracy of the

functions of the adjusted parameters. An effort was therefore made to fill this gap. Formulas are derived which are convenient for solving the formulated problem with recurrent adjustment of the surface geodetic network. A solution of the formulated problem is found in the following sequence:

1. Separate adjustment of surface geodetic system;
2. Separate adjustment of space geodetic system;
3. Joint adjustment of the two networks.

An algorithm is written which makes it possible, in evaluating the accuracy of the functions in a surface geodetic network, to take into account the results of adjustment of a surface geodetic network on a sounder basis than in previously proposed methods. Figure 1; references: 6 Russian.

**Work on Evaluating Role of Ocean in Global CO<sub>2</sub> Budget (23d Cruise of Vityaz Scientific Research Ship) (16 August-14 November 1991)**

927N0145E Moscow *OKEANOLOGIYA* in Russian  
Vol 32 No 3, May-Jun 92 pp 609-612

[Article by M. Ye. Vinogradov; UDC 577(261)(262.5)]

[Abstract] The objective of the 23d cruise of the Vityaz (1991) in the northern part of the Atlantic Ocean (map, Fig. 1) and Black Sea (map, Fig. 2) was research on the global carbon cycle, in particular, the flux of carbon from the atmosphere through the eutrophic production zone of the ocean into its deeper layers. The research program included the following: study of the hydrological characteristics of Black Sea waters and regions of different productivity in the North Atlantic; determination of the spectrum of underwater irradiance and incident radiation; estimation of vertical and spatial nonuniformities of fluorescence intensity, turbidity, spectral coefficient of sea brightness, structure of bioluminescence field; evaluation of correlation between contact and satellite measurements. All these data were used in studying the variability of the production and destruction processes manifested in waters of different trophicity with an estimate of the biomass and numbers of microheterotrophic organisms, including bacteria and different size groups of mesozooplankton. The role played by different groups of heterotrophic organisms in destruction and the total production of detritus and its part which sinks from the eutrophic zone into the ocean depths were computed on the basis of their biomass, metabolism, trophic relationships and special features of vertical distribution for waters of different trophicity. This made it possible to estimate the ratio of production and destruction in associations and its change with a change in the trophicity of waters. Figures 2.

**Kamchatkan Volcanic Ash as Potential Hazard for Passenger Airlines**

927N0120A Moscow *VULKANOLOGIYA I SEISMOLOGIYA* in Russian No 3, May-Jun 92  
(manuscript received 1 July 91) pp 16-36

[Article by V. Yu. Kiryanov, Volcanic Geology and Geochemistry Institute, Far Eastern Department, Russian Academy of Sciences, Petropavlovsk-Kamchatskiy; UDC 551.21]

[Abstract] Three cases are cited which illustrate the hazard posed to aircraft by explosive eruptions of volcanoes. Particular emphasis is on volcanic eruptions on Kamchatka. In addition to the direct entry of volcanic ash particles into aircraft engines there are other types of danger: sharp reduction of visibility, interference in radio communication and malfunctioning of aircraft electronic systems. There are 29 active and potentially active volcanoes on Kamchatka and several eruptions of different intensity occur annually. Accordingly, an evaluation of the explosive activity of Kamchatkan volcanoes during the last 10 years is made for determining the

possible intervals and directions of movement of ash clouds from future eruptions relative to flight safety. The following factors are examined: characteristics of atmospheric circulation, type, frequency and duration of eruptions, distribution of products of volcanic eruptions in atmosphere and altitude ranges and directions of movement of ash clouds. Pertinent data are presented in a series of figures and tables. The past and potential activity of the most important volcanoes is summarized. The most dangerous is Klyuchevskoy volcano; Bezymyanny and Shiveluch are the next most dangerous. Figures 9; references 30: 19 Russian, 11 Western.

**Accuracy in Evaluations of Future Climatic Conditions**

927N0111A Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 5, May 92 (manuscript received 4 Jul 91) pp 5-13

[Article by M. I. Budyko, State Hydrological Institute; UDC 551.583.14]

[Abstract] Methods for computing the accuracy of evaluations of anticipated changes in climatic conditions during the development of global warming are discussed. It is shown that among the reliable predictions of anthropogenic changes in climate it is possible to include only those which are confirmed by the consistency of not less than two independent methods for computing future climatic conditions. Positive results of a comparison of the results of use of methods having a similar validation are a necessary but inadequate condition for proof of the reliability of any predictions. A negative result of such a comparison demonstrates the unreliability of the predictions. The best-known example is a comparison of computations of change in climatic elements by theoretical methods which indicate the possible correctness of the evaluation of anticipated temperature changes and the unreliability of data on regional precipitation changes. The positive results found from a comparison of regional temperature and precipitation anomalies based on completely independent paleoanalogues relating to different warm epochs are evidence of a relatively high reliability of the results of empirical predictions. A quantitative validation of the predictability of the considered climatic change is of great importance. This predictability is always limited, in some cases is absent and in many cases is not determined by the accuracy in theoretical or empirical models of climate but by the reliability of information on the chemical composition of the atmosphere in the future, and sometimes also by other factors exerting an influence on climate. Even now it is possible to discriminate those estimates of climatic conditions of the future which are adequately reliable for practical use. In the practical application of such estimates it is necessary to take into account their real accuracy as established by totally unquestionable methods. References 11: 8 Russian, 3 Western.

### Change in Atmospheric Chemical Composition During 21st Century

927N0111B Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 5, May 92 (manuscript received 4 Jul 91) pp 14-24

[Article by I. L. Karol, K. I. Selyakov and I. Ye. Turchinovich, Main Geophysical Observatory; State Hydrological Institute; UDC 551.583.14:551.510.41]

[Abstract] A prediction of atmospheric CO<sub>2</sub> content up to the middle of the 21st century was obtained by an analysis of published models and the results of computations made at the State Hydrological Institute using a box model of the carbon cycle in which a biogenous entry of CO<sub>2</sub> into the atmosphere from 0 to limiting values was considered. A study also was made of CO<sub>2</sub> escape into the atmosphere. The rate of increase in industrial discharge did not exceed 1.4 percent per year and was not less than 0.3 percent per year as an average for 60-65 years. The following estimates of future atmospheric carbon dioxide concentration (in million<sup>-1</sup>) are made: 2000 (374+/-9); 2025 (423+/-1); 2050 (480+/-40). Four different scenarios developed in the USSR and the United States were examined in detail. Long-term predictions were made using radiation-photochemical models of the atmosphere. The principal contribution to the error in predictions of the gas composition of the atmosphere is introduced by uncertainties in the scenarios of escape of greenhouse gases (Table 2). Table 3 gives the equivalent CO<sub>2</sub> contents in the atmosphere in the past, and with allowance for the data in Table 2, to the end of the next century. The errors in equivalent concentrations caused by prediction errors are also given for the 21st century; these data are deemed entirely reliable up to the middle of the 21st century. Figures 3; references 29; 10 Russian; 19 Western.

### Principal Patterns of Regional Pollution of Terrain by Aerosol Source

927N0111C Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 5, May 92 (manuscript received 12 Nov 91) pp 25-37

[Article by V. M. Voloshchuk, A. I. Kupriyanchuk and L. V. Mladinaya, Tayfun Scientific Production Association; Kiev State University; UDC 551.510.72:551.510.522:551.511.61]

[Abstract] The experience of studying fallout from the accident at the Chernobyl nuclear power plant made it clear that improved methods are required for studying such phenomena. The principal similarity tests for the process of pollution of the terrain by such an aerosol impurity were therefore formulated (with a whole series of assumptions) and validated for a situation when it is sufficient to make allowance only for the sedimentation

of particles, vertical turbulent mixing in the atmospheric boundary layer and horizontal transfer with an arbitrary vertical profile of the horizontal wind. The transverse dispersal of impurity is examined in a Gaussian approximation. The characteristic regularities of behavior of a local aerosol impurity associated with the influence of vertical turbulent mixing are determined. Computed data on terrain pollution are given for different similarity test values. In the mathematical simulation use was made of only two physicochemical characteristics of the impurity: rate of sedimentation of particles and rate of "dry" precipitation onto the underlying surface. The method is applicable in predictions under critical circumstances when there is radioactive pollution of the environment at distances from several tens to several hundreds of kilometers from the source. Figures 3; references: 5 Russian.

### Climate and Water Budget of Caspian Sea

927N0111D Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 5, May 92 (manuscript received 15 Jul 91) pp 75-80

[Article by V. V. Lobanov, State Hydrological Institute; UDC 551.58+551.465.71(262.81)]

[Abstract] Since 1977 the Caspian Sea has risen about 1 ½ meters, resulting in serious economic consequences. Accordingly, using all available data a detailed study was made of changes in the Caspian Sea water budget for the period 1978-1989. All sea level random and systematic components were evaluated. Computations were made which confirm that a change in climate exerted a considerable influence on variations in Caspian Sea level from 1880 through 1989. The warmings of the 1930's and 1980's corresponded to a positive change in Caspian Sea level. A comparison of the spatial and seasonal changes in the mean temperature anomaly of the lower air layer during these warmings indicated that the warming of the 1930's considerably exceeded the warming of the 1980's not only in winter, but also in summer, especially in the first half of the 1980's when the temperature increase in summer was relatively insignificant. The increase in atmospheric transparency observed in the 1930's ensured that the climatic system received such an additional heat influx as has not yet been observed in the high latitudes during the warming of the 1980's. An appreciable lessening of the temperature increase at the end of the 20th century thereby changed moistening conditions for the European USSR: due to an intensification of cyclonic activity the quantity of precipitation increased significantly over an extensive territory of the wooded zone. This explains the increase in runoff of the Volga, which with a simultaneous change in evaporation and the quantity of precipitation resulted in an increase in Caspian Sea level in the late 1970's, an increase which is still continuing. Figure 1; references: 8 Russian.

**Anticipated Changes in Ice and Thermal Regimes of Rivers Accompanying Construction of Kansk-Achinsk Fuel-Power Complex**

927N0111E Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 5, May 92 (manuscript received 1 Nov 91) pp 81-84

[Article by A. M. Filippov, State Hydrological Institute; UDC (556.535.4+556.535.5):627.8(282.256.142)]

[Abstract] The results of computations of the heat budget of water bodies of the Kansk-Achinsk Fuel-Power Complex (KATEK) under the planned conditions make it possible to anticipate considerable changes in the ice and thermal regimes of regional rivers under the influence of three-four operating or projected thermal electric power plants. A study was made of the feasibility of the concentrated placement of state regional electric power plants relative to the predicted high anthropogenic impact on the Beresh, Uryup and Chulym Rivers. In determining the long-range prospects of KATEK development particular attention must be given to an estimate of the thermal impact on the Uryup River when all three power plants reach their full production level. With their operation during extremely warm summer months the additional heating of the water may be 8-10° and this will be sensed even in the mouth sector, especially in the zone of the planned Nizhne-Uryup Reservoir, intended for supplying water to a fourth power plant. The water temperature there will be only 2-3°C lower than in the Verkhne-Uryup Reservoir, where its levels in July will attain 34°C. The temperature also will be high during the period of spring spawning of fish and this will exert a negative influence on fishing. Already with the construction of three thermal electric power plants their heat discharge will result in considerable changes in the thermal and ice regimes of the Uryup river. In the event that a fourth plant is put on line the impact would be still greater. This and additional factors give rise to serious questions concerning the feasibility of the concentrated placement of multiple power plants in this area. It is necessary to seek ways to reduce this load even in the stage of operation of the first power plant (Berezovo). Figure 1; references: 5 Russian.

**Possibilities for Precision Measurements of O<sub>3</sub> and NO<sub>2</sub> Content From Solar Radiation Absorption Spectra From Space**

927N0109A Moscow IZVESTIYA AKADEMII NAUK RAN: FIZIKA ATMOSFERY I OKEANA in Russian Vol 28 No 5, May 92 pp 500-505

[Article by V. V. Rozanov, Yu. M. Timofeyev, A. V. Polyakov, J. P. Burrows and K. Chance, Leningrad State University; M. Planck Chemistry Institute, Mainz, FRG; Smithsonian Observatory, United States; UDC 551.501.793]

[Abstract] The possibilities of using a new class of multispectrum apparatus in the UV and visible spectral regions (SCIAMACHY videospectrometer) for highly

precise measurements of the vertical profiles of O<sub>3</sub> and NO<sub>2</sub> profiles are discussed. The analysis revealed the following. An interpretation of atmospheric transparency measurements on slant paths during daytime and nighttime with different aerosol states of the atmosphere makes it possible to ensure a uniform accuracy in retrieving the O<sub>3</sub> vertical profile in the altitude range 20-65 km, which is 0.1-0.3°. In the altitude range 10-20 km the O<sub>3</sub> content retrieval accuracy is considerably lower. The potential accuracy in retrieving the vertical NO<sub>2</sub> profile is about 5° in the altitude range 22-38 km and decreases to about 10° near about 40 km. This retrieval accuracy must be regarded as the maximum accuracy possible because there are other sources of errors (but the same applies to all other instruments). It is therefore concluded that the SCIAMACHY outfit is the best available for determining the O<sub>3</sub> and NO<sub>2</sub> contents in a wide range of altitudes and that it can be used for standard measurements of atmospheric characteristics. Optimum performance requires a high accuracy in knowledge of the characteristics of interaction between radiation and the atmosphere, especially information on the ozone absorption coefficient. Figure 1; references 8: 3 Russian, 5 Western.

**Cartographic Support for Ecology and Environmental Protection Measures Based on Use of Data From Remote Sounding of Earth**

927N0123B Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 92 pp 43-48

[Article by S. S. Karpukhin, V. V. Kiselev and V. V. Sveshnikov; UDC 528.94:528.88]

[Abstract] For the purposes of ecological mapping ecology is regarded as the branch of science and sphere of practical activity synthesizing knowledge and solving scientific problems related to the interaction of organisms and their associations with the environment and ecological mapping is therefore a method for representing such interaction. The historical steps leading to the development of true ecological mapping are reviewed. Space methods have become the key tool making effective ecological mapping possible. Systematic ground- aerospace monitoring of the environment is developing rapidly and plans call for the integration of the masses of information now available for producing series of ecological maps of different areas at different scales for depicting particular and general ecological conditions. Ecological maps of republics, krays and oblasts will be revised periodically as necessity dictates. During the first five-year cycle in the preparation of ecological maps it is proposed that a series of maps be published for the Russian Federation and regions with complex ecological conditions, such as the Arctic zone, oil- and gas-producing regions of Western Siberia, zone of Chernobyl and Chelyabinsk radioactive contamination, Volga Basin, Baykal region, Western Caspian region and others. The maps will show the following:

natural conditions of life of population, territorial preserves, biota, landscape-ecological and ecological-topographic features, pollution of atmosphere, waters, snow cover, soils, disruption of geological medium, geochemical anomalies (caused by heavy metals, pesticides, etc.), disruptions in use of land resources, disturbances of vegetation and anthropogenic loads of various types, and finally, prediction of ecological state. Mapping at the oblast level will begin with territories having the most acute ecological conditions. References: 9 Russian.

### Research on Intermittence of Hydrophysical Fields Near Frontal Zone

927N0128C Sevastopol MORSKOY  
GIDROFIZICHESKIY ZHURNAL in Russian No 2,  
Mar-Apr 92 (manuscript received 30 Nov 90, after  
revision 17 Apr 91) pp 71-75

[Article by I. D. Bakanov, A. S. Borisov and A. M. Kudin, Geochemistry and Analytic Chemistry Institute imeni V. I. Vernadskiy, USSR Academy of Sciences, Moscow; UDC 551.465]

[Abstract] A study was made of the structural features of a frontal zone and also the intermittence of the statistical structure of hydrophysical fields based on measurements of scalar characteristics. Research on the quasistationary subpolar front was carried out in a test range in the northwestern part of the Sea of Japan on the 10th cruise of the Akademik Boris Petrov. Hydrophysical parameters were measured using a towed MGI-4204 CTD probe at a fixed horizon 50 m. Towing was at 5 m/s and spatial resolution was 7.5 m. The test range was investigated along 14 linear runs corresponding to intersection of the maximum spatial gradients of scalar fields. The runs were 30 miles long and were 5 miles apart. Detailed structural elements of the frontal zone were obtained from the results of a hydrological section of five stations using a "MARK-III" CTD probe. A T,S analysis of the vertical structure at depths 30-100 m made it possible to discriminate three types of curves: 1st—south of the frontal zone, 2d—in the frontal zone, 3d—to the north of the front. On the basis of discrimination of inhomogeneities in the horizontal statistical structure of scalar hydrophysical fields, employing the excess computed using a moving interval, an experimental size distribution of discriminated inhomogeneities was found which is approximated well by an exponential distribution. Figures 4; references 8: 5 Russian, 3 Western.

### Estimates of Radiation and Temperature Consequences of Ozone Content Changes in Global Atmosphere During 1980-1990

927N0148B Moscow DOKLADY AKADEMII NAUK  
in Russian Vol 323 No 1, Mar 92 (manuscript received  
10 Jan 92) pp 66-69

[Article by I. L. Karol and V. A. Frolkis, Main Geophysical Observatory imeni A. I. Voyeykov, St. Petersburg; UDC 551.28+551.58]

[Abstract] The changes in the mean zonal, mean annual receipts of solar and thermal radiation and the temperature changes in different layers of the atmosphere caused by them during the period 1980-1990 are estimated using a two-dimensional energy balance radiative-convective model of the mean zonal, mean annual atmosphere (a model proposed by the authors in METEOROLOGIYA I GIDROLOGIYA, No 8, pp 59-68, 1984 and elsewhere). The problem is examined in two variants and several subvariants. A series of tables gives data on the mean annual, mean global mixing ratios of greenhouse gases in the troposphere during this period, change in the mean annual ozone content in different atmospheric layers in different latitude ranges during this period and changes in effective receipts of solar and total radiation at the tropopause level in different variants due to changes in the content of various greenhouse gases. An analysis of these data shows that the considered changes in the radiation and thermal regimes are attributable to changes in the concentration of ozone and other greenhouse gases. The estimates show that an appreciable radiation influence, associated with the change in ozone content, on the increasing greenhouse effect of the remaining greenhouse gases can occur only in the polar zones, especially in the south polar region, and in the southern middle latitudes where a significant role is played by the Antarctic ozone hole. A consequence of such ozone compensation of the greenhouse warming of the south polar zone in the 1980's may be the observed difference in the snow-covered area on the continents and on marine polar ice; while the total areas of both have decreased in the Arctic they have persisted in Antarctica. References 6: 2 Russian, 4 Western.

### Modern Trends in Arctic Climatic Change

927N0146A Moscow DOKLADY AKADEMII NAUK  
in Russian Vol 322 No 5, Jan 92 (manuscript received  
17 Dec 91) pp 865-868

[Article by Ye. I. Aleksandrov and A. P. Nagurnyy, Arctic and Antarctic Scientific Research Institute, St. Petersburg; UDC 551.524.3(98)]

[Abstract] The polar regions can provide important clues to global climatic changes. The last change in the direction of the trend of annual temperature in the Arctic was in the mid-1960's. Temperature in the Arctic began to increase slowly. However, this increase has been transpiring nonuniformly, in jumps, and during the last decade it slowed down sharply. The mean annual temperature for the period 1981-1990 became higher than the mean annual temperature of the preceding decade by 0.6°C. The principal temperature increase occurred in a jump in one to three years between 1979 and 1981. During the last decade the warming of the Arctic has sharply decreased and during the winter and autumn periods there have even been negative trends in change in middle-latitude temperatures. This does not correspond to the anticipated scenario of warming of the high latitudes due to anthropogenic greenhouse effects.

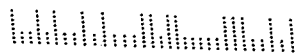
Model estimates give a maximum temperature increase at the surface precisely in the high latitudes. However, for the time being this is not being observed. A sharp change in the direction of the trends also is characteristic for the polar latitudes. The last change during the century from a rapid to an almost background trend was observed in 1983-1984. This

indicates an intransitive or multimodal nature of climatic change in the high latitudes in which a transition from one set of statistics (one climate) to another set of statistics (another climate) occurs in a jump whose prediction is difficult due to the operation of many factors (randomness) in the processes causing this jump. Figures 2; references: 3 Russian.

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